Lec-16 6/11

$$X(s) = \frac{1}{s+a} \qquad \frac{1}{\sigma + j\omega} \qquad \cancel{\frac{1}{s}}$$

$u(t) \rightarrow \boxed{x(t) = \frac{1}{s}} \; ~~Re\{s\}~~ \; 0 \qquad \{1 - 1\}$

0

$$\boxed{\frac{1}{0}} \quad \infty \; X$$

$$Re\{s\} < -a$$
$$> -a$$

LT 9 final

Proofs

$$h(t) * x(t) = y(t)$$

LT

$$H(s) \cdot X(s) \xrightarrow{LT^{-1}} Y(s)$$

IR

$$x(t) \rightarrow \boxed{h(t)} \rightarrow y(t)$$

S

$X(s)$ $H(s)$ $Y(s)$

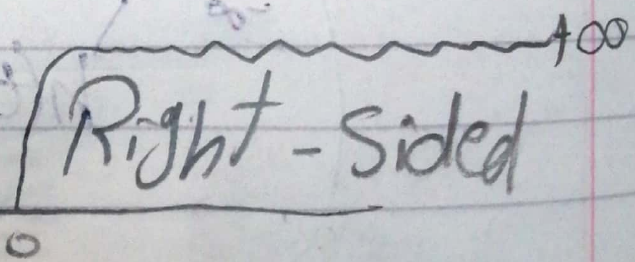
Transfer function
system function

$Y = X\,H$

$$\boxed{H = \frac{Y(s)}{X(s)}}$$

Causal:

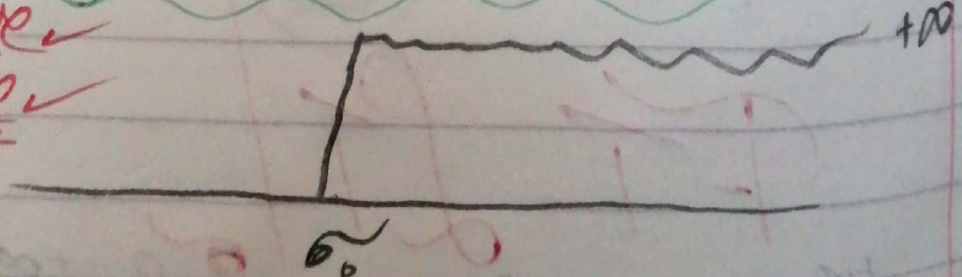
$h(t) = 0 \ \forall \ t < 0$



RoC

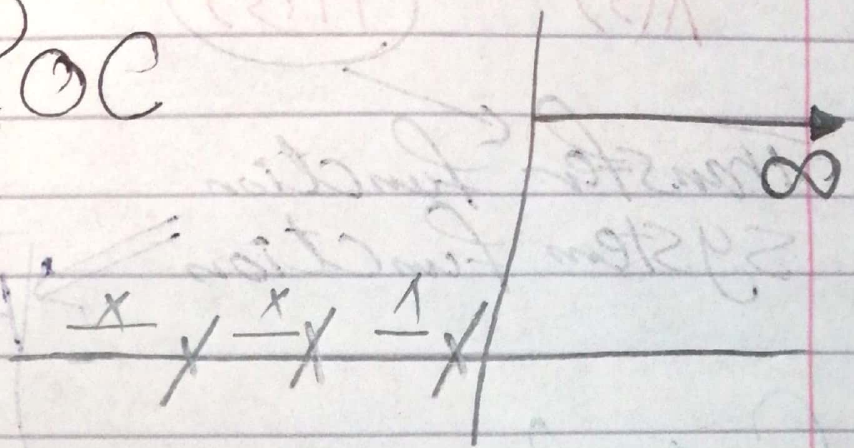
Right-half Plane.

σ_0 +ve ✓
-ve ✓



Causal :- $\frac{N(s)}{D(s)} \rightarrow$ Poles

ROC



Stable :- $\int_{-\infty}^{+\infty} |h(t)|\,dt < \infty$

$h(t)$ Can be Complex.

FT exist

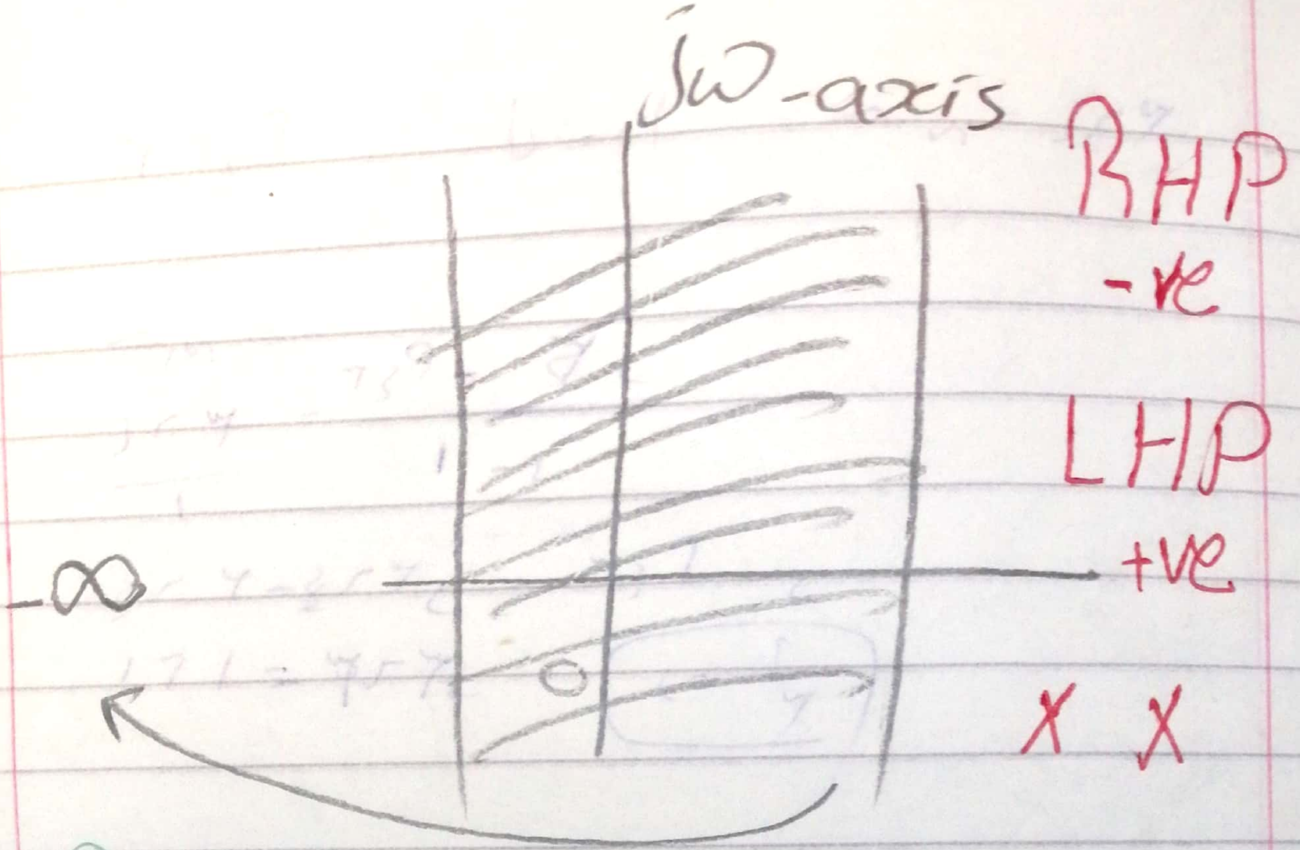
$FT = LT \Big|_{\sigma=0}$

$\boxed{\sigma = 0}$

$(\sigma + j\omega)$

$$\int_{-\infty}^{+\infty} x(t) e^{-j\omega t} dt = \int_{-\infty}^{+\infty} x(t) e^{-st} dt$$

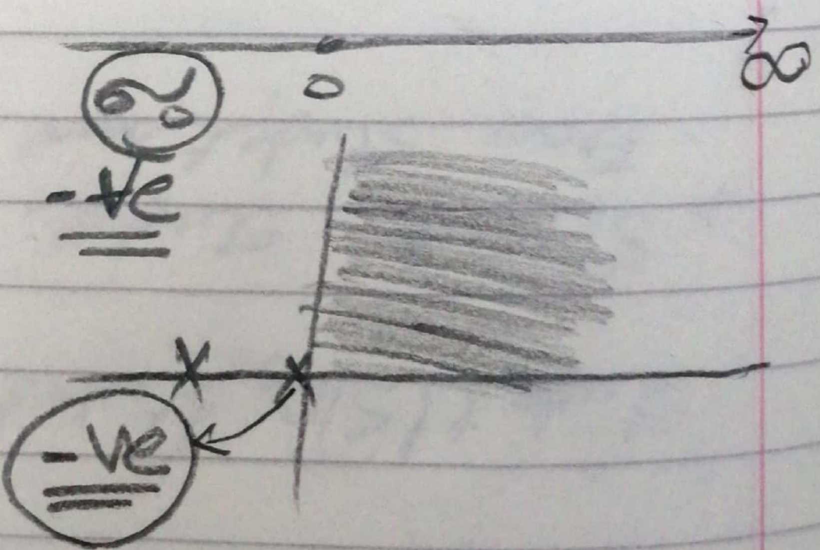
$e^{-j\omega t}$



Causal
Stable

$$\left\{ \frac{N(s)}{D(s)} \right\}$$

X X
Poles



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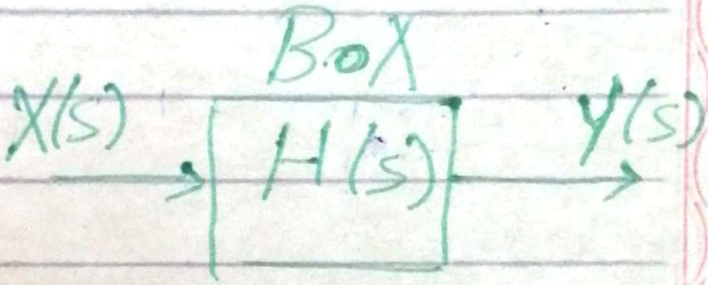
Date : / /201 التاريخ : / / ٢٠١

Block Diagram & System Algebra

* Elements :-

① Block :-

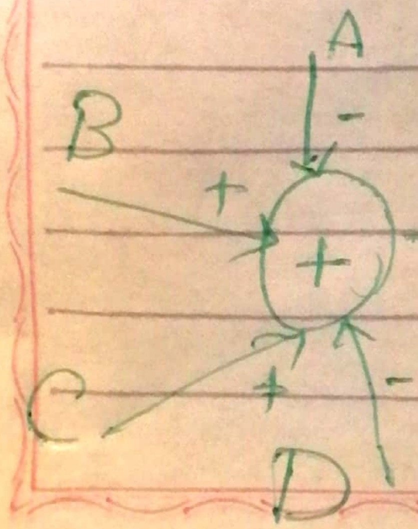


system / sub system / Component / device.

$Y(s) = X(s)\, H(s)$.

② Summing Point :- ⊕ ; ⊗

Perform summation
subtraction
(Combination)



ONE output

Multiple Input

$Y = B + C - (A + D)$

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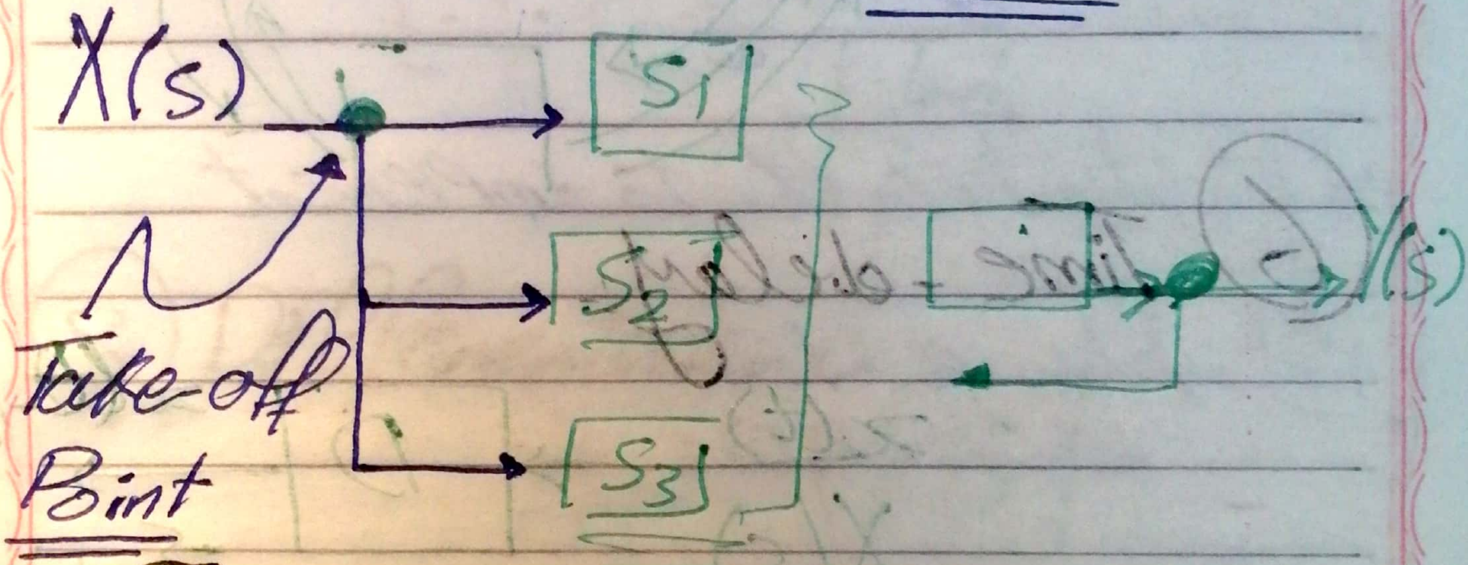
Date : / / 201 التاريخ : / / ٢٠١

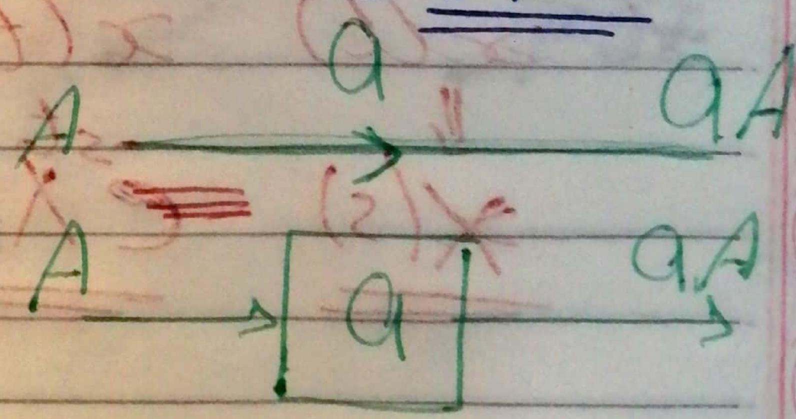
③ Take-off Point :-

ONE InPut → Multiple OutPut



④ Branch :-

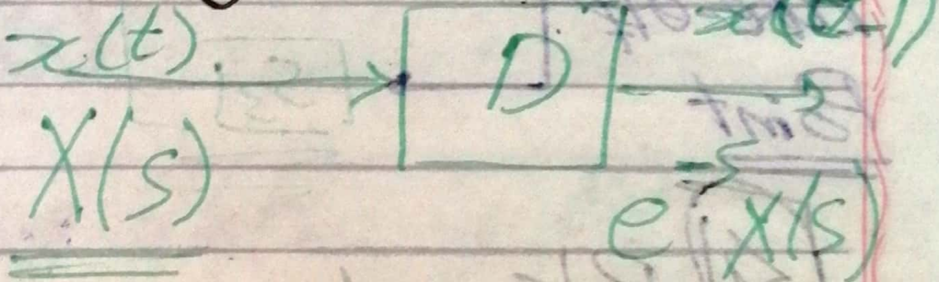
Scaling Coefficient



⑤ Arrow :-

(flow of signals)

⑥ Time-delay :-



$x(t)$ $\Downarrow$ $\underline{X(s)}$ $\qquad$ $x(t-t_0)$ $\quad$ $\underline{e^{-st_0}X(s)}$

Subject :

Date : / / 201

7 Integrator :-

$x(t) \rightarrow \boxed{\int} \rightarrow y(t)$

$$y(t) = \int_{-\infty}^{+\infty} x(\tau)\, d\tau$$

$$\boxed{\frac{1}{s}}$$

8 Differentiator :-

$$\boxed{s}$$

$$s\, Y(s)$$

$$\frac{d\, y(t)}{dt}$$

~~$s \frac{dy}{dx}$~~

Subject:

Date: / /201

Largest Power $= \frac{1}{s^2}$

in term of differentiator $\rightarrow$

$$H(s) = \frac{s^2 + s - 3}{s^2 - 4s - 3}$$

in term of Integrator $\rightarrow$

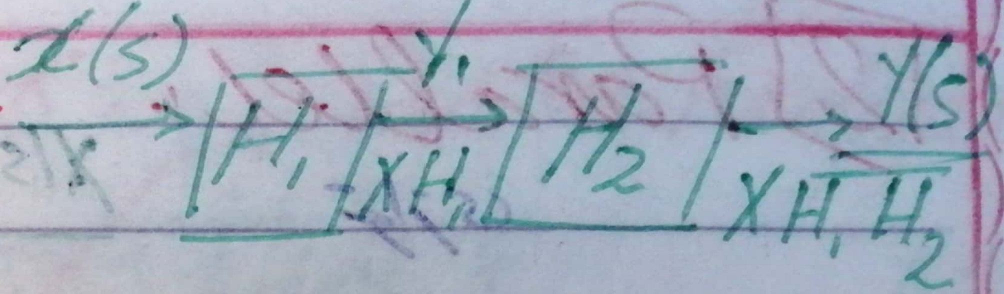
$$H(s) = \frac{1 + \frac{1}{s} - 3 \cdot \frac{1}{s} \cdot \frac{1}{s}}{1 - \frac{4}{s} - 3 \cdot \frac{1}{s} \cdot \frac{1}{s}}$$

[1] difficult to implement

[2] Phrune to errors
$\equiv$ sensitive to noise.

disadventages of differentiators

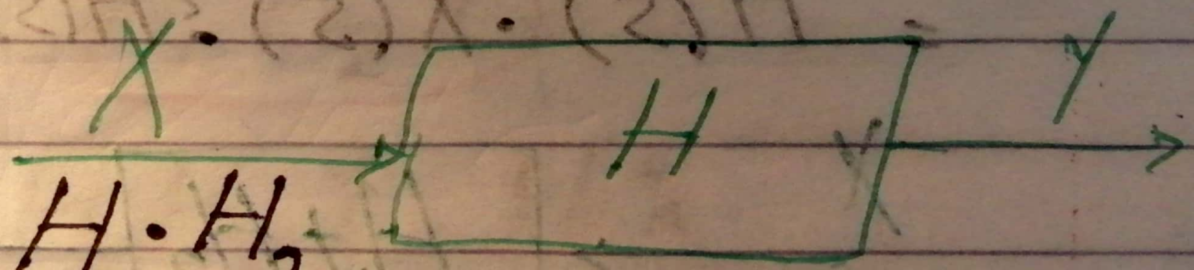
[1] Series :- توالي



$$Y(s) = H_2 H_1 X$$

$$= \{H_1(s) \cdot H_2(s)\} X(s)$$

$$= H(s)\, X(s)$$

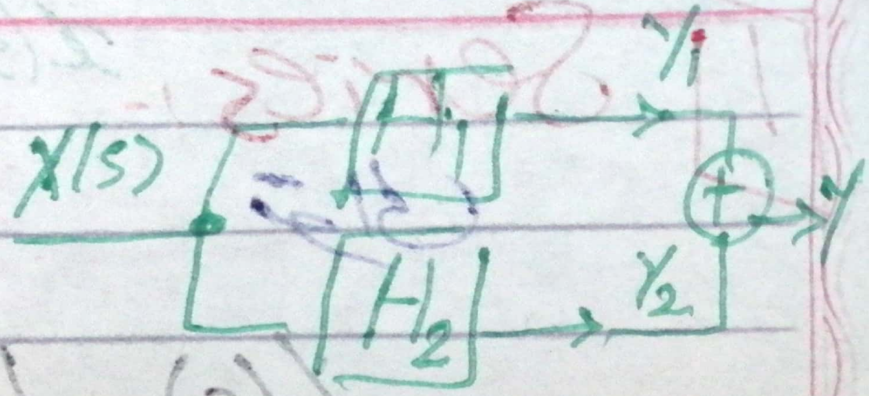


$$\therefore \underline{\underline{H = H_1 \cdot H_2}}$$

Date : / /201

$\boxed{2}$ Parallel:

توازي

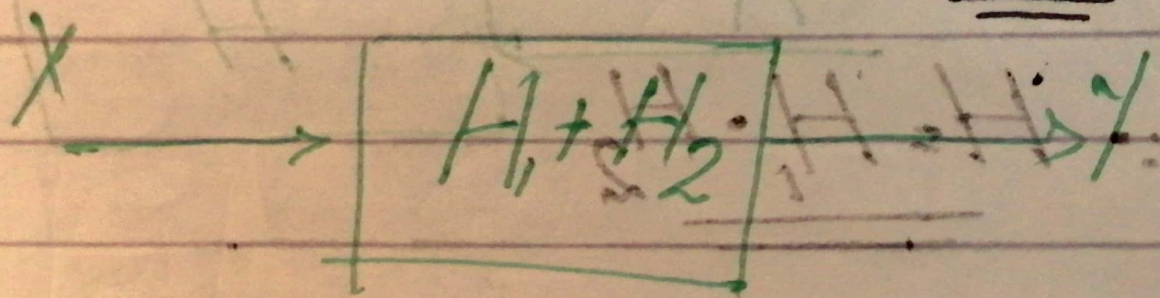


$$Y = Y_1 + Y_2$$

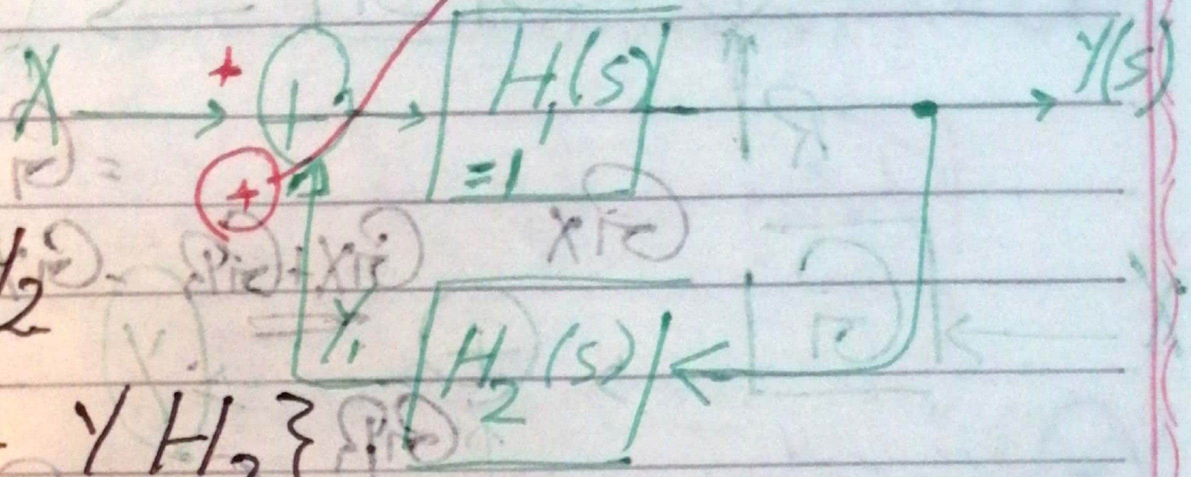
$$= XH_1 + XH_2$$

$$= X(H_1 + H_2)$$

$$= H(s) \cdot X(s) \Rightarrow H(s) = \underline{\underline{H_1}}(s) \cdot \underline{\underline{H_2}}(s)$$



3 Feedback :- Positive feedback



$$Y_1 = Y H_2$$

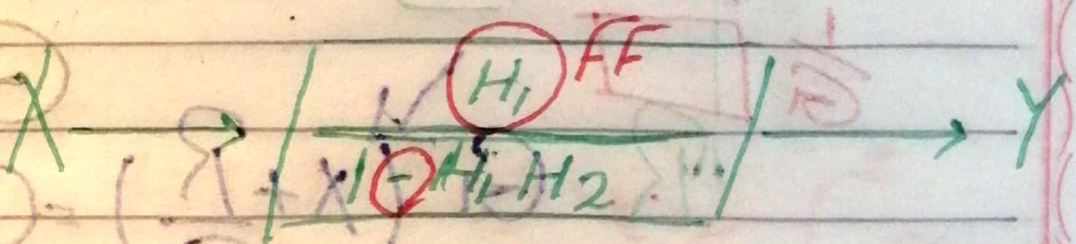
$$Y = H_1 \{ X + Y H_2 \}$$

$$Y = H_1 X + H_1 H_2 Y$$

$$Y - H_1 H_2 Y = H_1 X$$

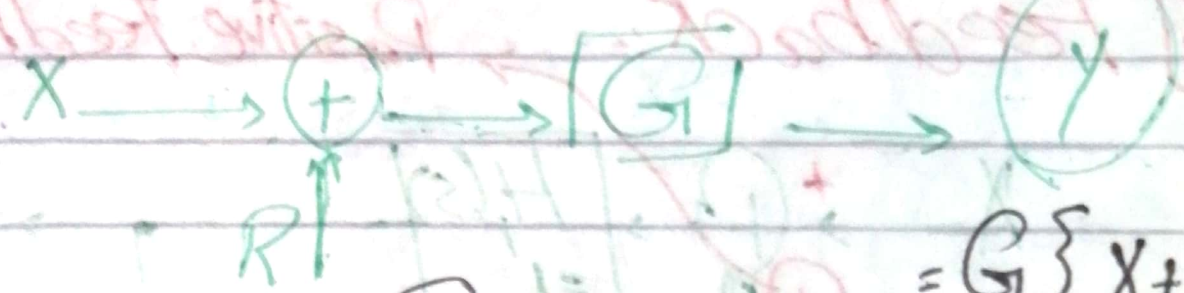
$$Y(1 - H_1 H_2) = H_1 X$$

$$\therefore \frac{Y(s)}{X(s)} = \frac{H_1(s)}{1 - H_1(s) H_2(s)} = H(s)$$



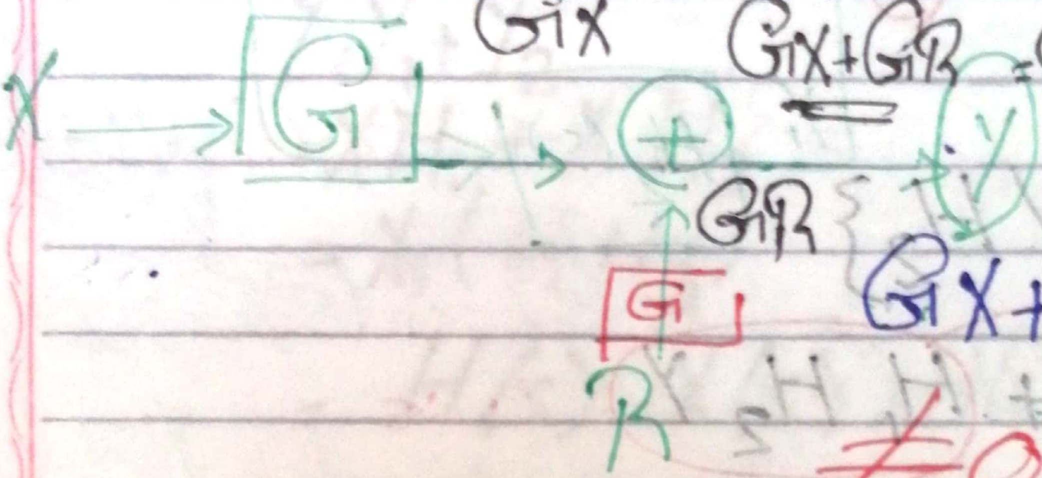
Subject: ______ موضوع الدرس:

Date: / /201 التاريخ: / / ٢٠١



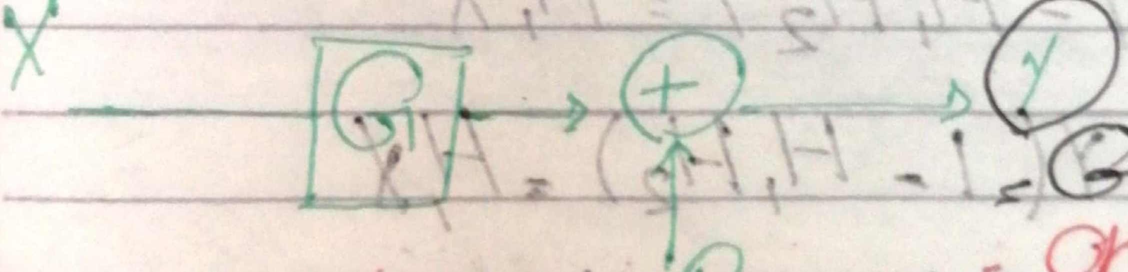
$= G\{X+R\}$

GX $\quad \underline{GX+GR} = GX+GR$



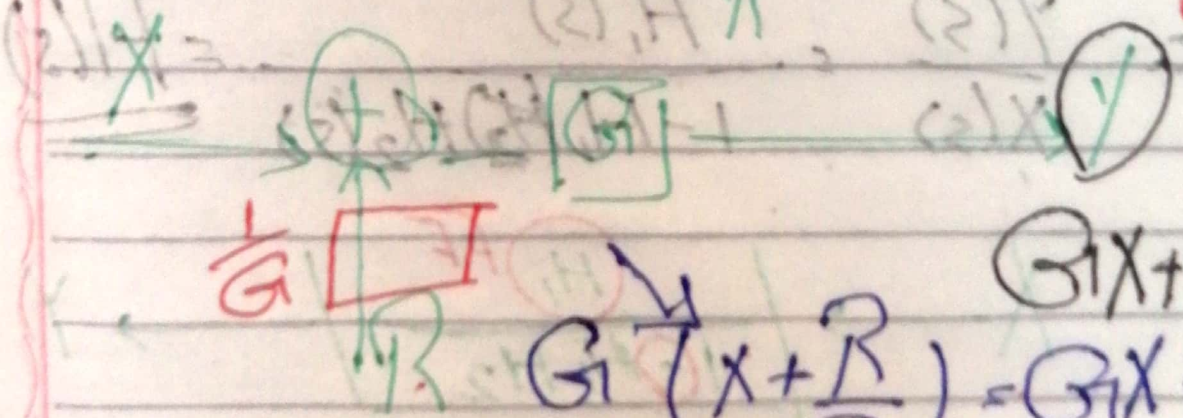
$GX+R \neq$

$\neq$ original(Y)



$= GX+R$

= original Y



$\neq$

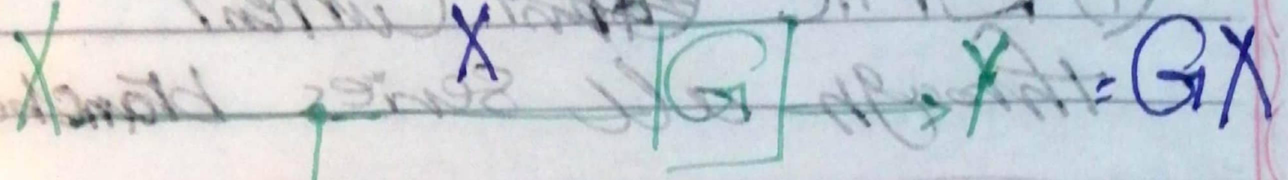
$GX+GR$

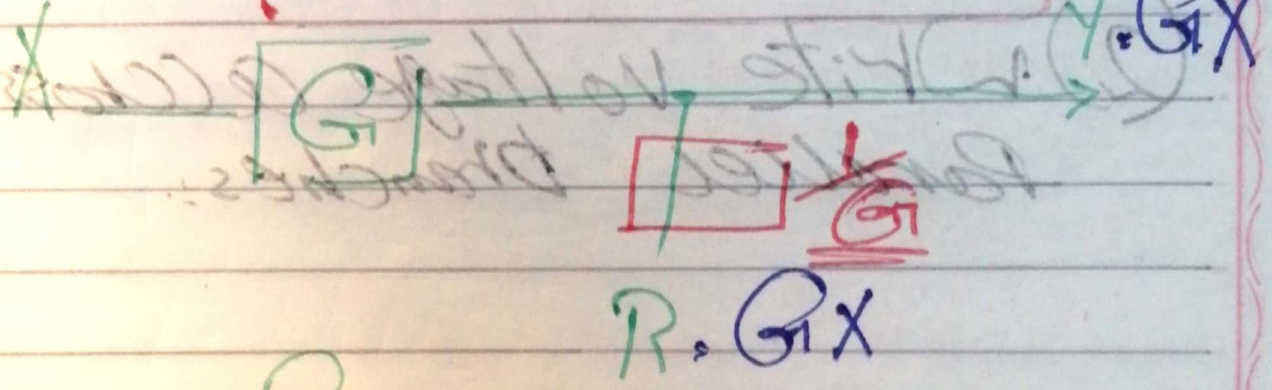
$G\left(X+\frac{R}{G}\right) = GX+R$

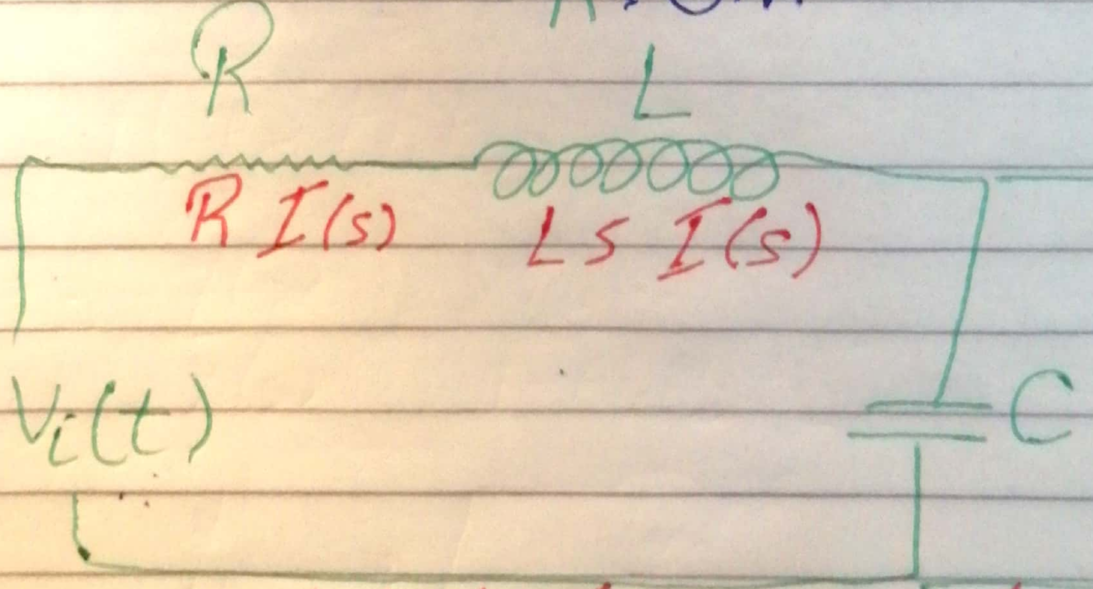
= original X

Subject: موضوع الدرس :

Date: / / 201   التاريخ : / / ٢٠١







$V_o(s) = \frac{1}{sC} I(s)$ $\quad v_c = \frac{1}{C}\int_{-t}^{t} I(t)\,d(t)$

Subject : موضوع الدرس :

Date : / / 201 التاريخ : / / ٢٠١

① Write ~~Cur~~ Current through all series branches:

$$\boxed{I(s) = \frac{V_i(s) - V_o(s)}{R + SL}}$$

② Write voltage accross Parallel branches: