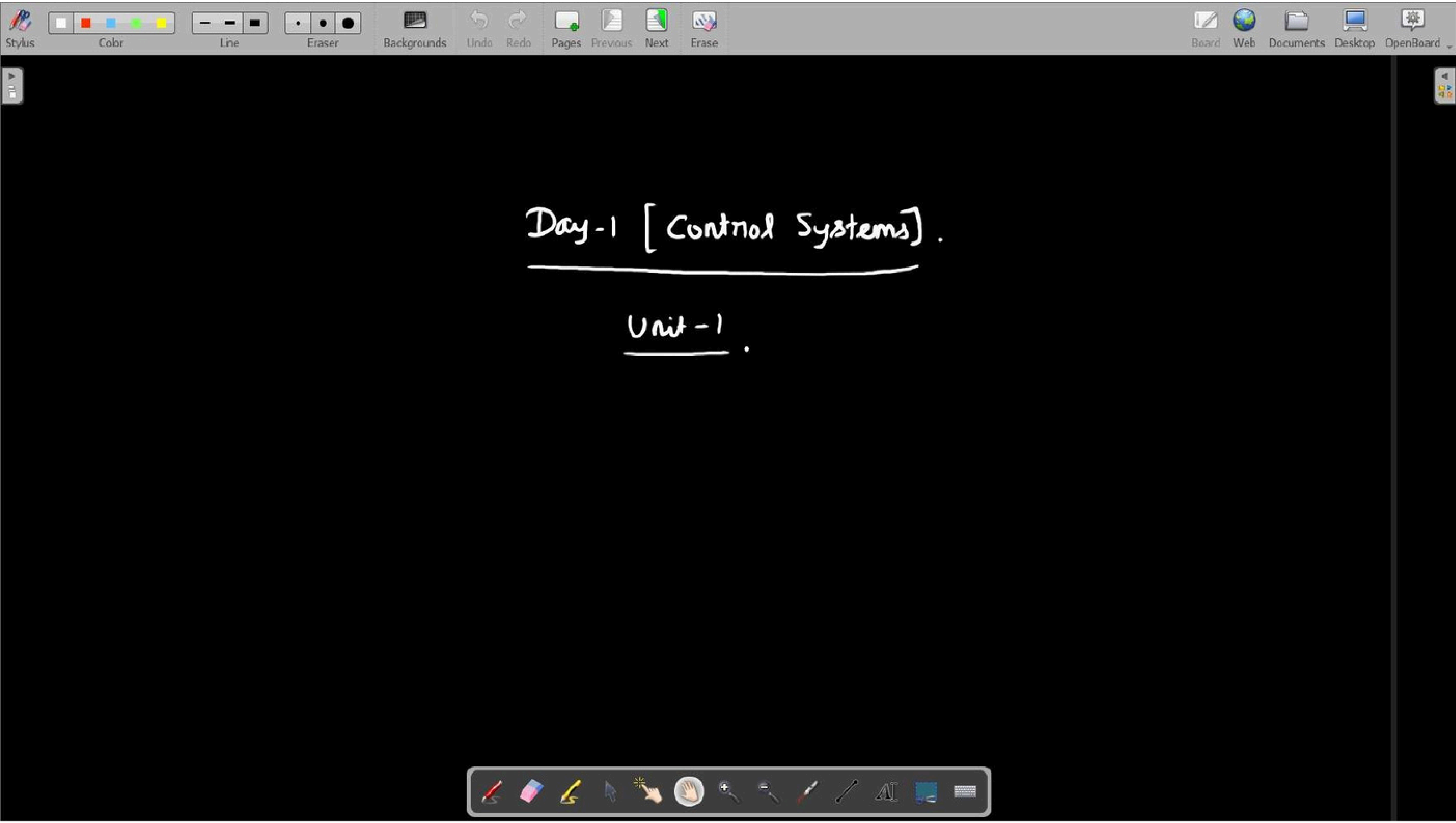
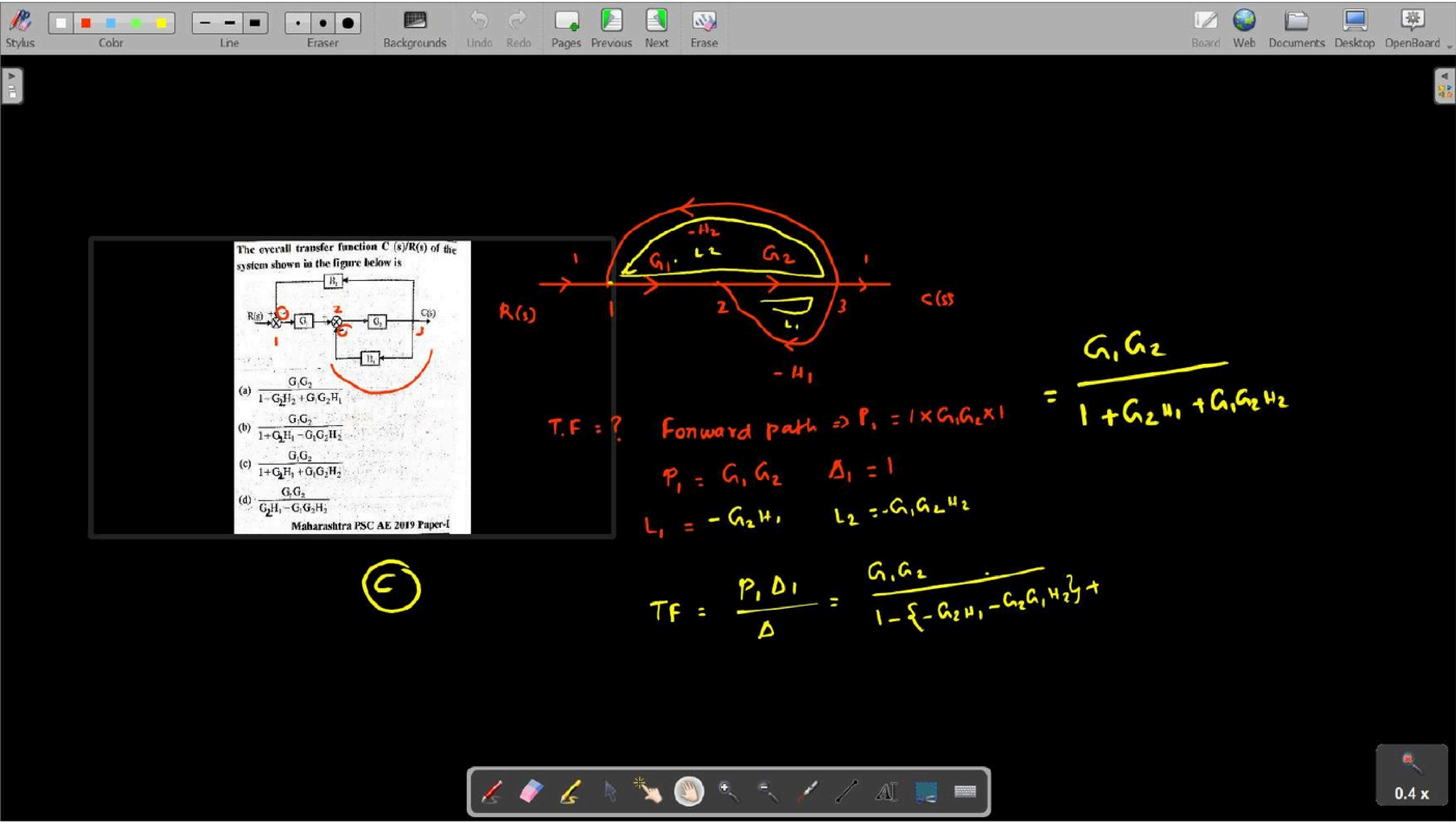


Day-1 [Control Systems].

Unit-1.

Full Video Link



The overall transfer function C (s)/R(s) of the system shown in the figure below is

(a) $\frac{G_1G_2}{1-G_2H_2+G_1G_2H_1}$

(b) $\frac{G_1G_2}{1+G_2H_1-G_1G_2H_2}$

(c) $\frac{G_1G_2}{1+G_2H_1+G_1G_2H_2}$

(d) $\frac{G_1G_2}{G_2H_1-G_1G_2H_2}$

Maharashtra PSC AE 2019 Paper-I

ⓒ

T.F = ?   Forward path ⇒ $P_1 = 1 \times G_1G_2 \times 1$

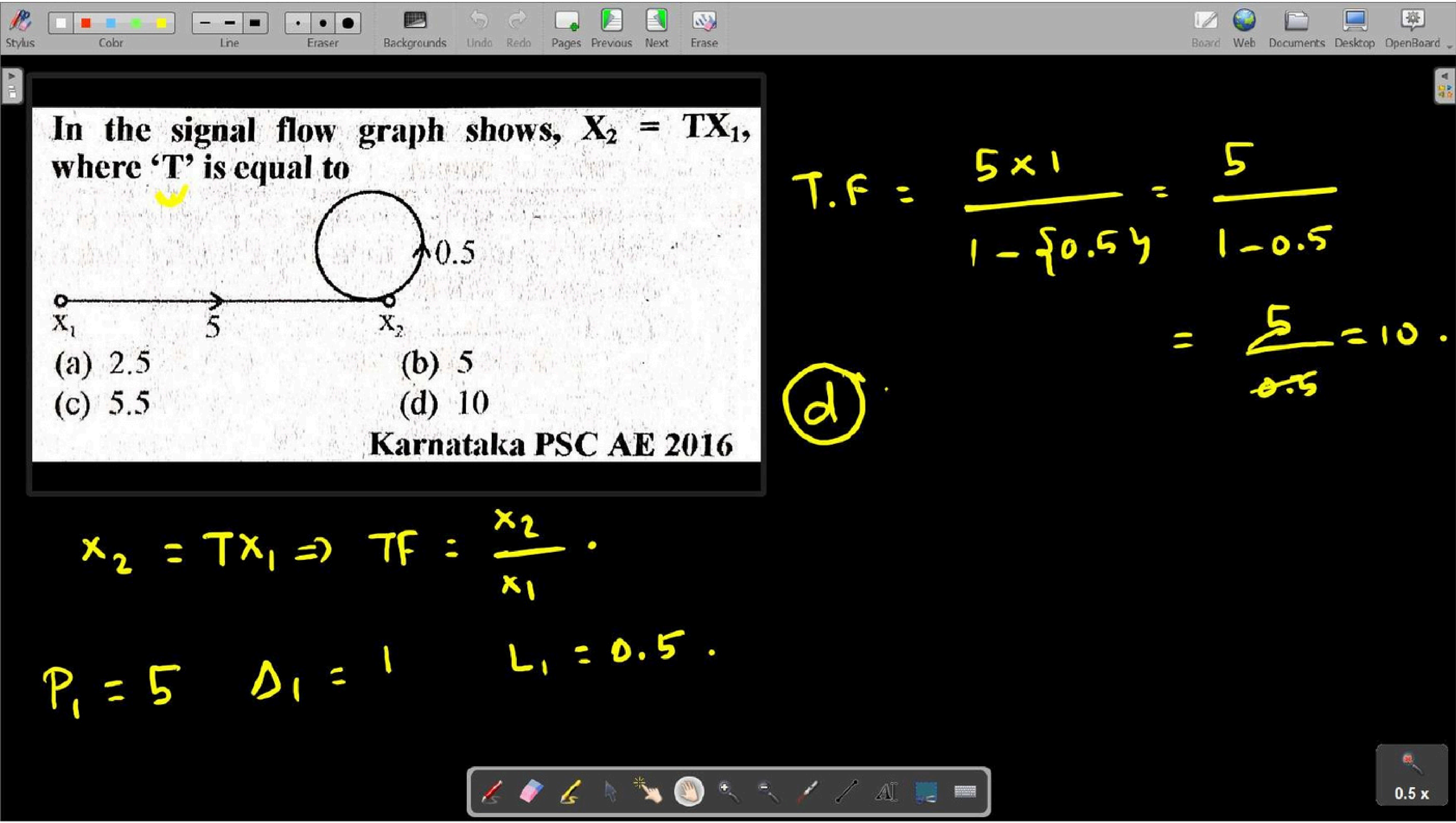
$P_1 = G_1G_2$ $\Delta_1 = 1$

$L_1 = -G_2H_1$ $L_2 = -G_1G_2H_2$

$$TF = \frac{P_1\Delta_1}{\Delta} = \frac{G_1G_2}{1-\{-G_2H_1-G_2G_1H_2\}+}$$

$$= \frac{G_1G_2}{1+G_2H_1+G_1G_2H_2}$$

Full Video Link



In the signal flow graph shows, $X_2 = TX_1$, where 'T' is equal to

(a) 2.5
(b) 5
(c) 5.5
(d) 10

Karnataka PSC AE 2016

$$x_2 = TX_1 \Rightarrow TF = \frac{x_2}{x_1}.$$

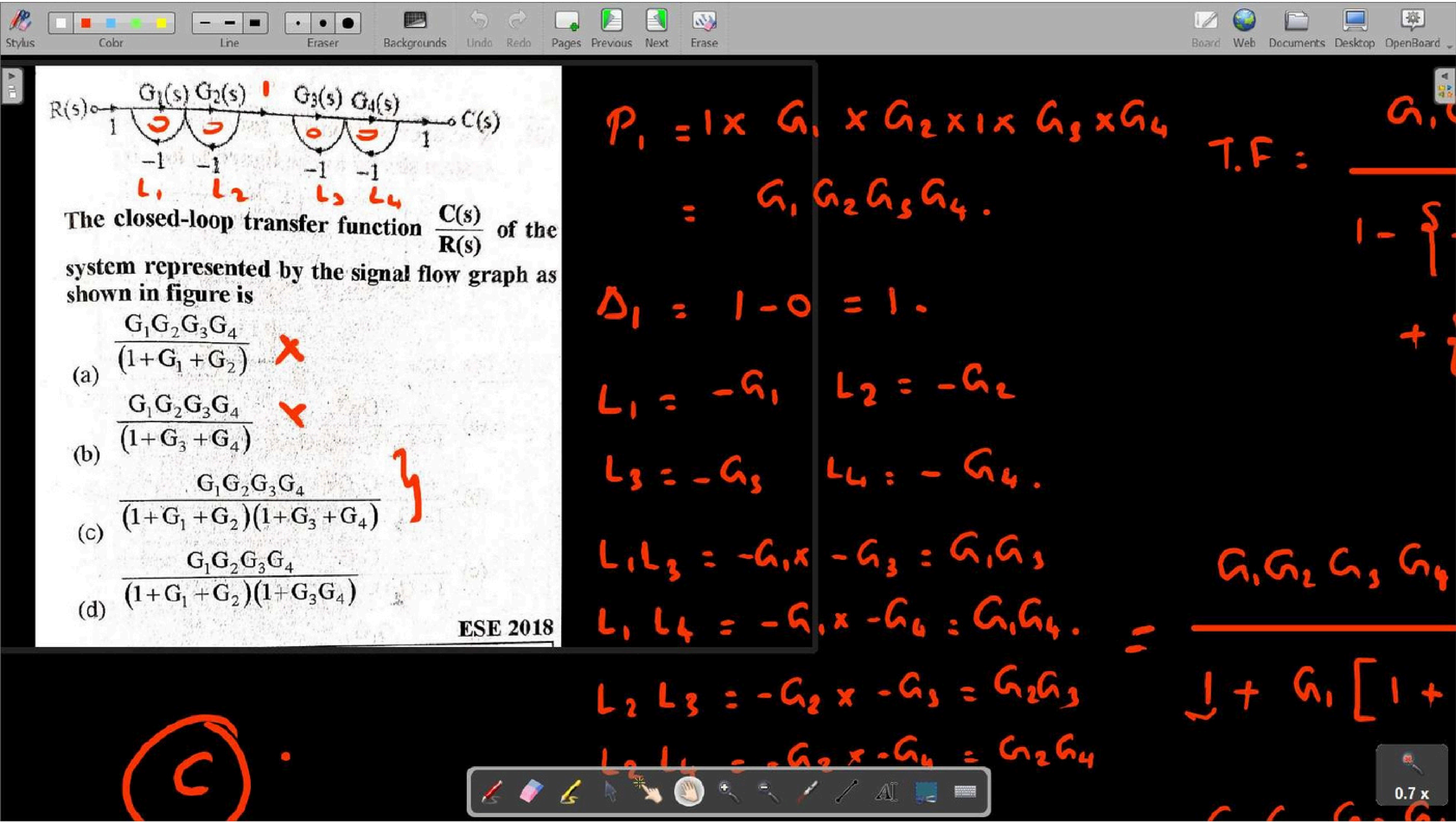
$P_1 = 5$ $\Delta_1 = 1$ $L_1 = 0.5.$

$$T.F = \frac{5\times 1}{1-\{0.5\}} = \frac{5}{1-0.5}$$

$$= \frac{5}{\cancel{0.5}} = 10.$$

ⓓ

Full Video Link



The closed-loop transfer function $\frac{C(s)}{R(s)}$ of the system represented by the signal flow graph as shown in figure is

(a) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)}$ ✗

(b) $\frac{G_1G_2G_3G_4}{(1+G_3+G_4)}$ ✗

(c) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)(1+G_3+G_4)}$ }

(d) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)(1+G_3G_4)}$

ESE 2018

$\boxed{C}$.

$P_1 = 1 \times G_1 \times G_2 \times 1 \times G_3 \times G_4$

$= G_1 G_2 G_3 G_4.$

$\Delta_1 = 1 - 0 = 1.$

$L_1 = -G_1 \quad L_2 = -G_2$

$L_3 = -G_3 \quad L_4 = -G_4.$

$L_1L_3 = -G_1 \times -G_3 = G_1G_3$

$L_1L_4 = -G_1 \times -G_4 = G_1G_4.$

$L_2L_3 = -G_2 \times -G_3 = G_2G_3$

$L_2L_4 = -G_2 \times -G_4 = G_2G_4$

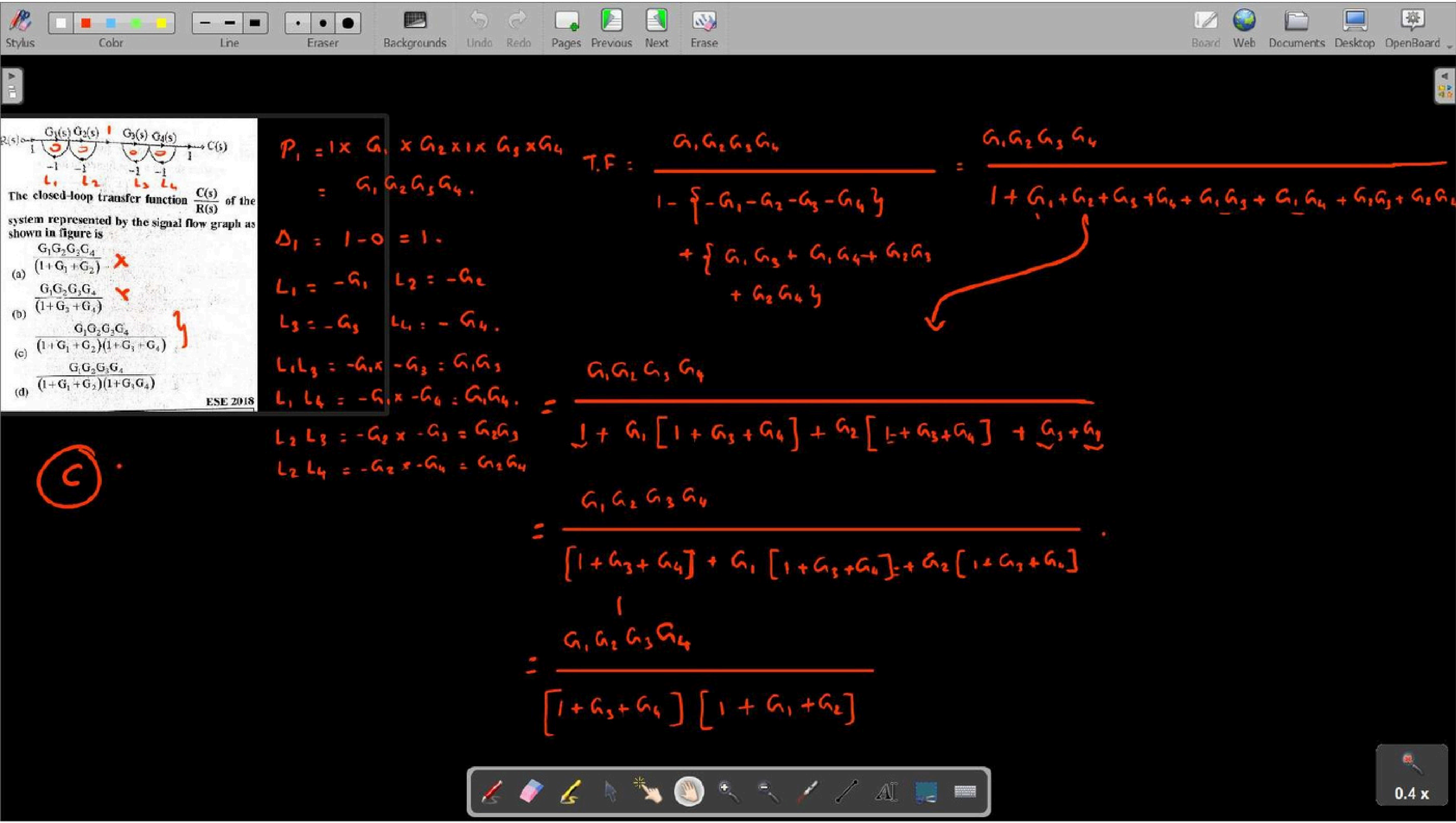
T.F = G_1

1 − Σ

+ Σ

= $\frac{G_1G_2G_3G_4}{1 + G_1[1 +}$

Full Video Link



The closed-loop transfer function $\frac{C(s)}{R(s)}$ of the system represented by the signal flow graph as shown in figure is

(a) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)}$ ✗

(b) $\frac{G_1G_2G_3G_4}{(1+G_3+G_4)}$ ✗

(c) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)(1+G_3+G_4)}$ }

(d) $\frac{G_1G_2G_3G_4}{(1+G_1+G_2)(1+G_3G_4)}$

ESE 2018

$P_1 = 1 \times G_1 \times G_2 \times 1 \times G_3 \times G_4$

$= G_1 G_2 G_3 G_4.$

$\Delta_1 = 1 - 0 = 1.$

$L_1 = -G_1 \quad L_2 = -G_2$

$L_3 = -G_3 \quad L_4 = -G_4.$

$L_1L_3 = -G_1 \times -G_3 = G_1G_3$

$L_1L_4 = -G_1 \times -G_4 = G_1G_4.$

$L_2L_3 = -G_2 \times -G_3 = G_2G_3$

$L_2L_4 = -G_2 \times -G_4 = G_2G_4$

(c).

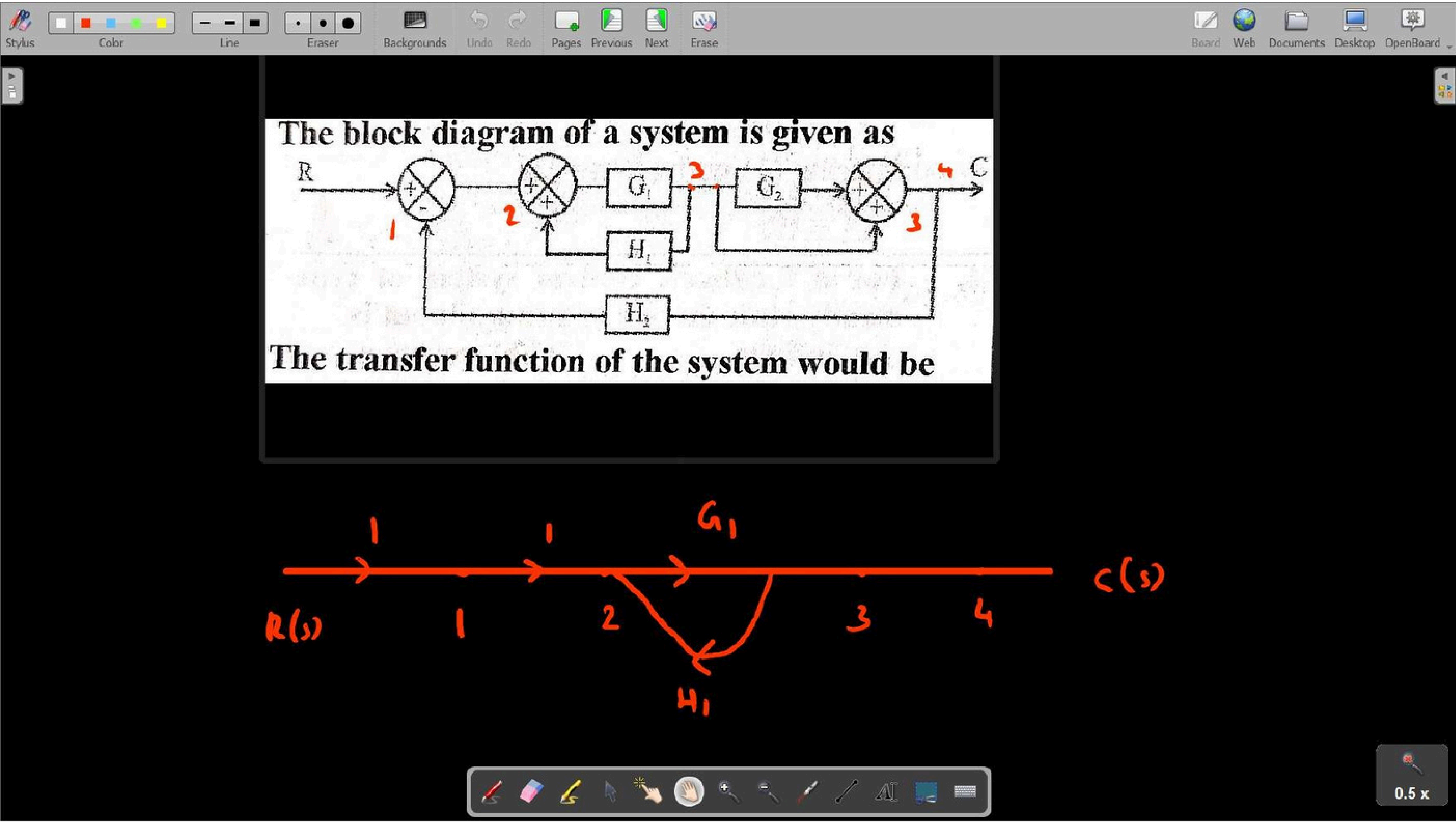
$$T.F = \frac{G_1G_2G_3G_4}{1 - \{-G_1 - G_2 - G_3 - G_4\} + \{G_1G_3 + G_1G_4 + G_2G_3 + G_2G_4\}} = \frac{G_1G_2G_3G_4}{1 + G_1 + G_2 + G_3 + G_4 + G_1G_3 + G_1G_4 + G_2G_3 + G_2G_4}$$

$$= \frac{G_1G_2G_3G_4}{1 + G_1[1 + G_3 + G_4] + G_2[1 + G_3 + G_4] + G_3 + G_4}$$

$$= \frac{G_1G_2G_3G_4}{[1 + G_3 + G_4] + G_1[1 + G_3 + G_4] + G_2[1 + G_3 + G_4]}.$$

$$= \frac{G_1G_2G_3G_4}{[1 + G_3 + G_4][1 + G_1 + G_2]}$$

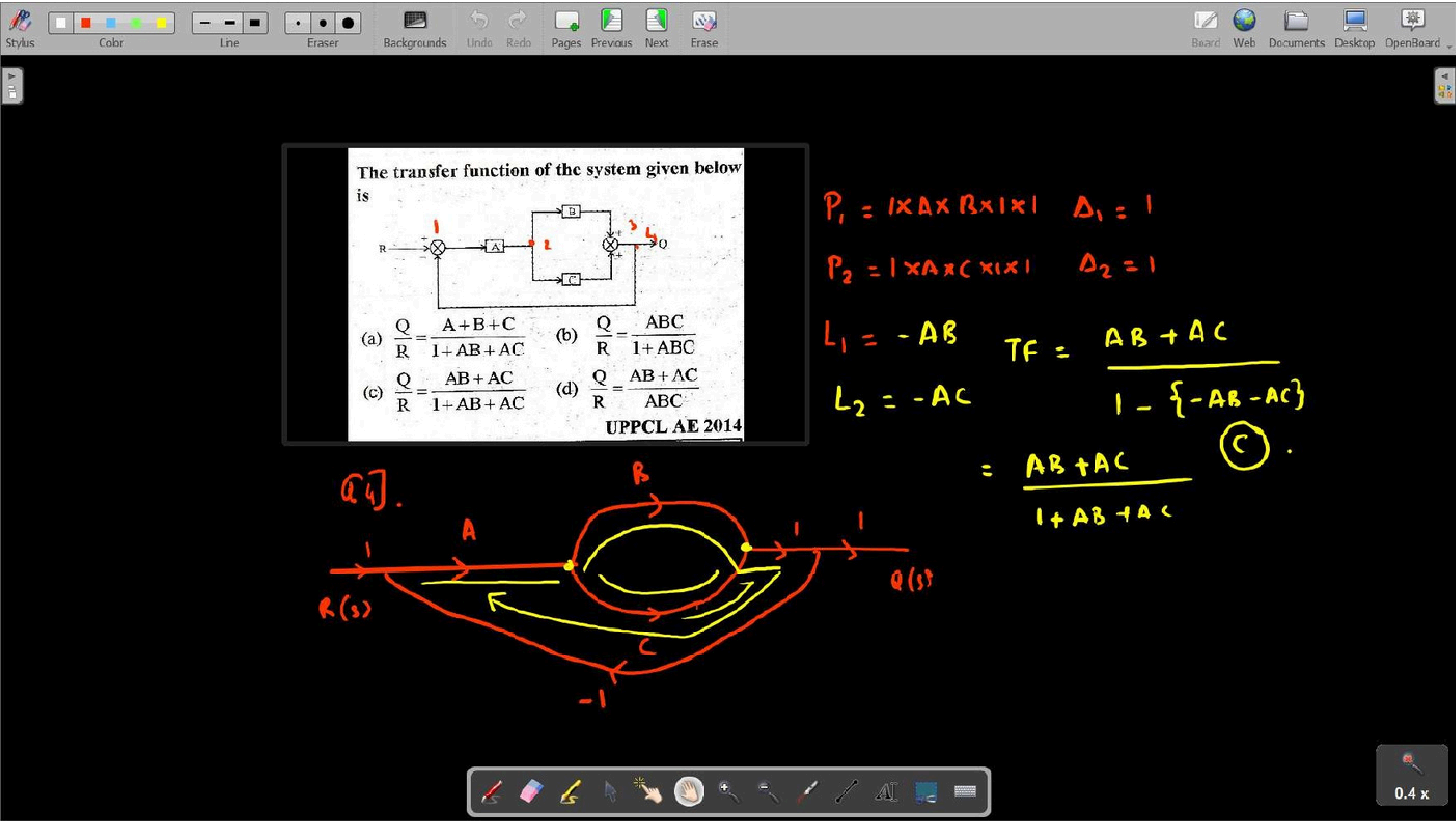
Full Video Link



The block diagram of a system is given as

The transfer function of the system would be

Full Video Link



The transfer function of the system given below is

(a) $\frac{Q}{R} = \frac{A+B+C}{1+AB+AC}$ (b) $\frac{Q}{R} = \frac{ABC}{1+ABC}$

(c) $\frac{Q}{R} = \frac{AB+AC}{1+AB+AC}$ (d) $\frac{Q}{R} = \frac{AB+AC}{ABC}$

UPPCL AE 2014

$P_1 = 1 \times A \times B \times 1 \times 1$ $\Delta_1 = 1$

$P_2 = 1 \times A \times C \times 1 \times 1$ $\Delta_2 = 1$

$L_1 = -AB$

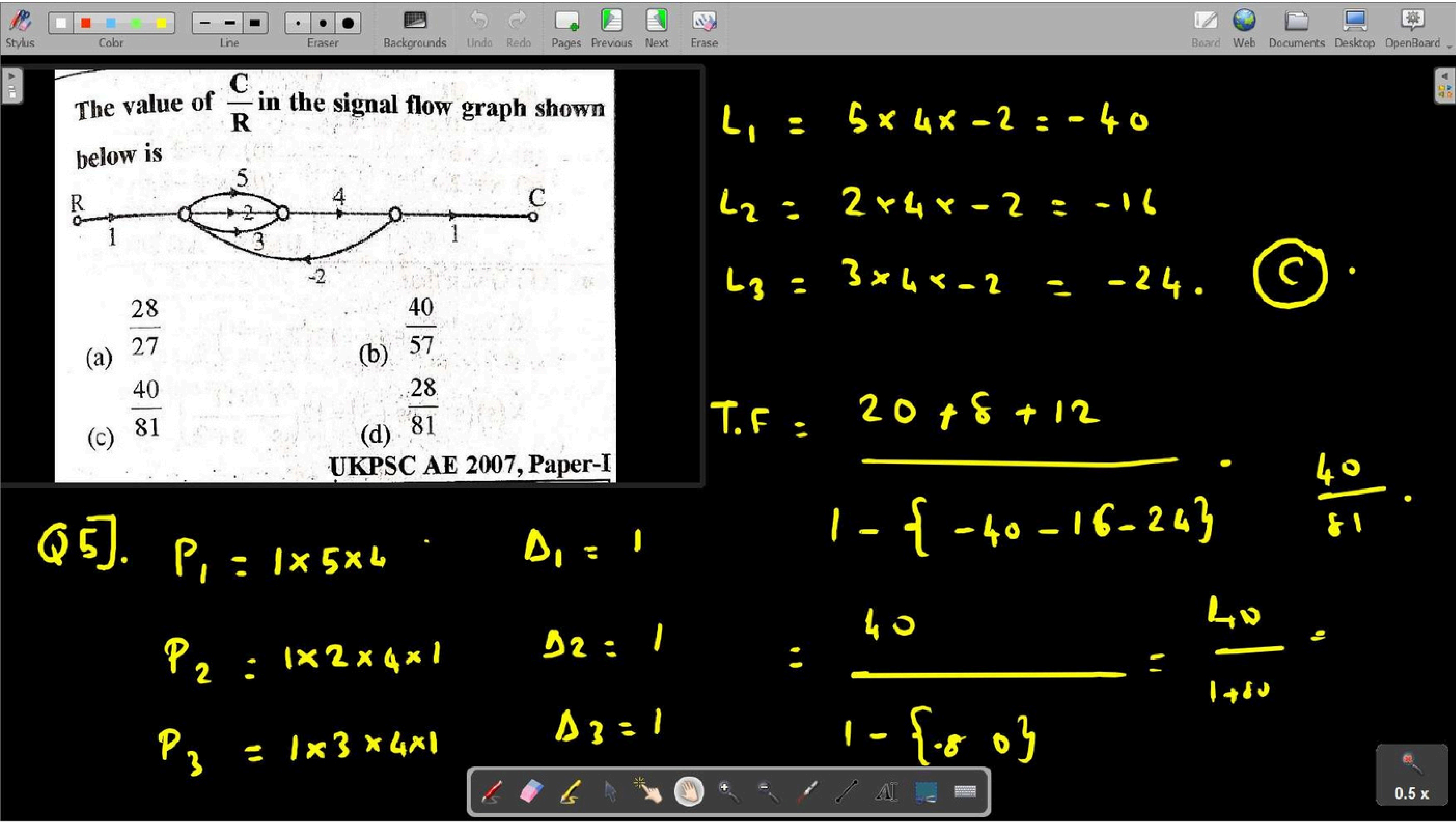
$L_2 = -AC$

$$TF = \frac{AB + AC}{1 - \{-AB - AC\}}$$

$$= \frac{AB + AC}{1 + AB + AC}$$

Ⓒ.

Full Video Link



The value of $\frac{C}{R}$ in the signal flow graph shown below is

(a) $\frac{28}{27}$
(b) $\frac{40}{57}$
(c) $\frac{40}{81}$
(d) $\frac{28}{81}$

UKPSC AE 2007, Paper-I

Q5]. $P_1 = 1 \times 5 \times 4$. $\Delta_1 = 1$

$P_2 = 1 \times 2 \times 4 \times 1$ $\Delta_2 = 1$

$P_3 = 1 \times 3 \times 4 \times 1$ $\Delta_3 = 1$

$L_1 = 5 \times 4 \times -2 = -40$

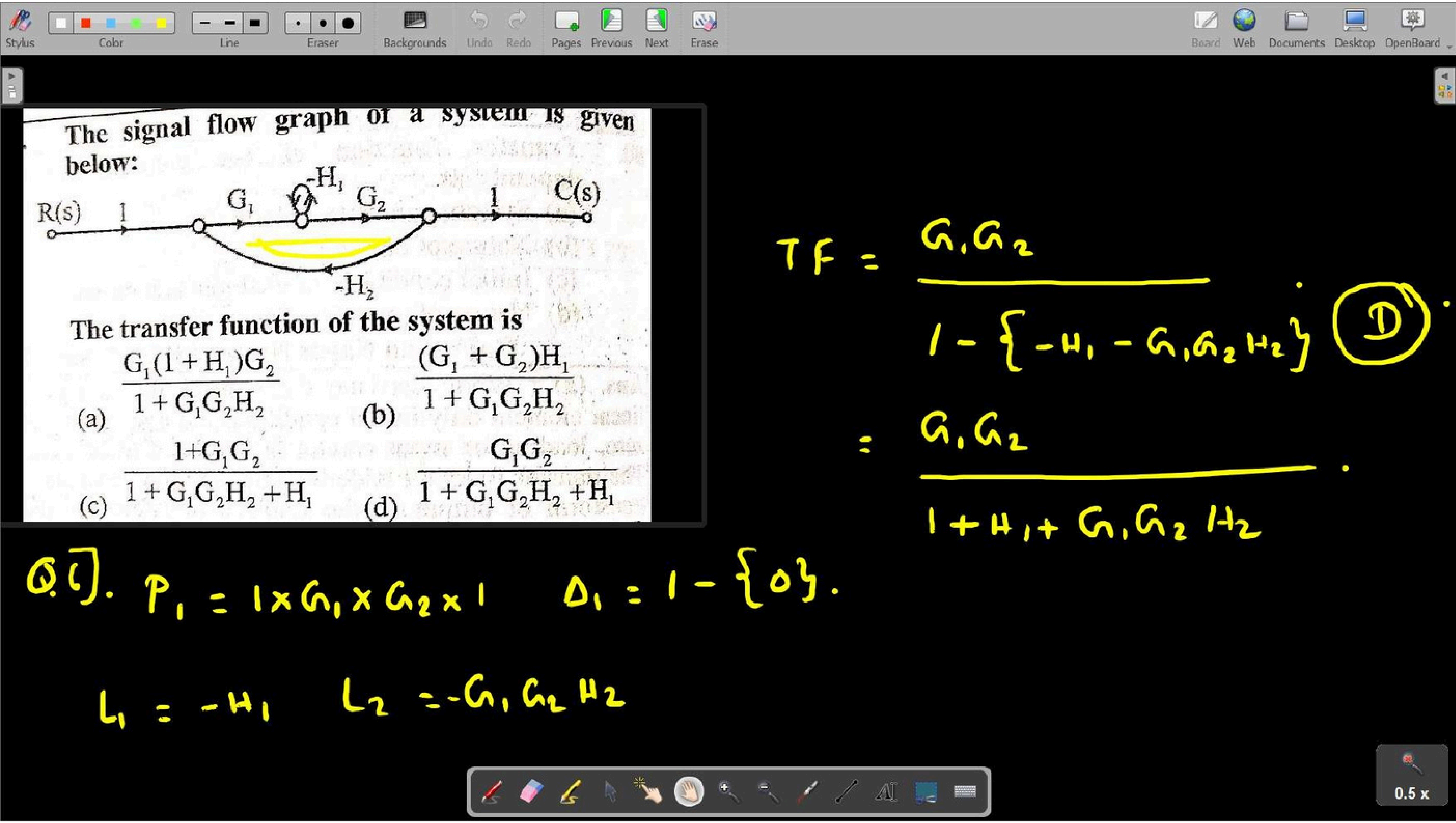
$L_2 = 2 \times 4 \times -2 = -16$

$L_3 = 3 \times 4 \times -2 = -24.$ Ⓒ.

$$T.F = \frac{20 + 8 + 12}{1 - \{-40 - 16 - 24\}} . \quad \frac{40}{81}.$$

$$= \frac{40}{1 - \{-8\ 0\}} = \frac{40}{1+80} =$$

Full Video Link



The signal flow graph of a system is given below:

The transfer function of the system is

(a) $\frac{G_1(1+H_1)G_2}{1+G_1G_2H_2}$ (b) $\frac{(G_1+G_2)H_1}{1+G_1G_2H_2}$

(c) $\frac{1+G_1G_2}{1+G_1G_2H_2+H_1}$ (d) $\frac{G_1G_2}{1+G_1G_2H_2+H_1}$

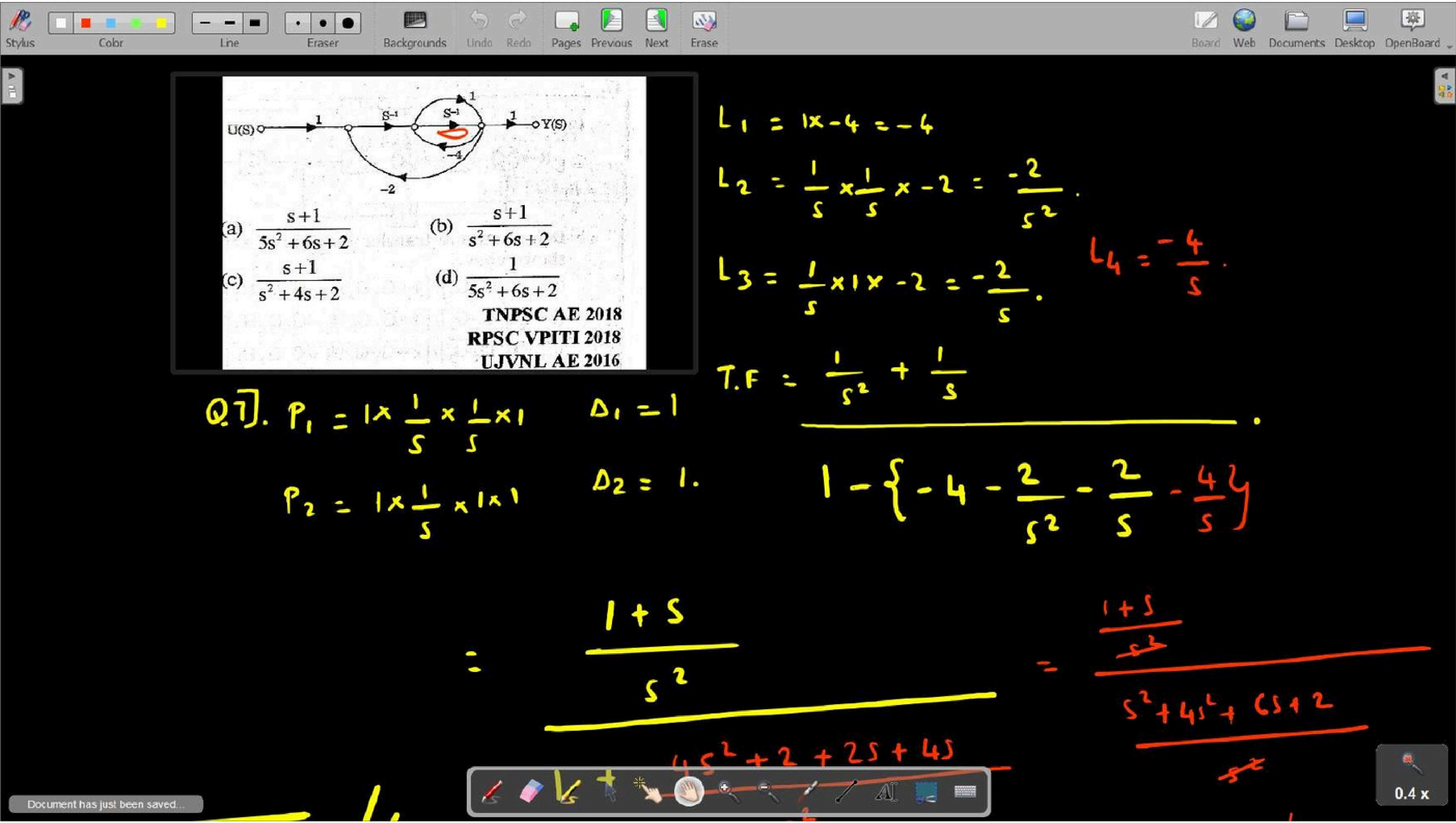
$$TF = \frac{G_1G_2}{1-\{-H_1-G_1G_2H_2\}}. \quad \boxed{D}.$$

$$= \frac{G_1G_2}{1+H_1+G_1G_2H_2}.$$

Q.(]. $P_1 = 1 \times G_1 \times G_2 \times 1$ $\Delta_1 = 1-\{0\}.$

$L_1 = -H_1$ $L_2 = -G_1G_2H_2$

Full Video Link



(a) $\frac{s+1}{5s^2+6s+2}$ (b) $\frac{s+1}{s^2+6s+2}$

(c) $\frac{s+1}{s^2+4s+2}$ (d) $\frac{1}{5s^2+6s+2}$

TNPSC AE 2018
RPSC VPITI 2018
UJVNL AE 2016

$L_1 = 1 \times -4 = -4$

$L_2 = \frac{1}{s} \times \frac{1}{s} \times -2 = \frac{-2}{s^2}.$

$L_3 = \frac{1}{s} \times 1 \times -2 = -\frac{2}{s}.$

$L_4 = \frac{-4}{s}.$

Q7]. $P_1 = 1 \times \frac{1}{s} \times \frac{1}{s} \times 1$ $\Delta_1 = 1$

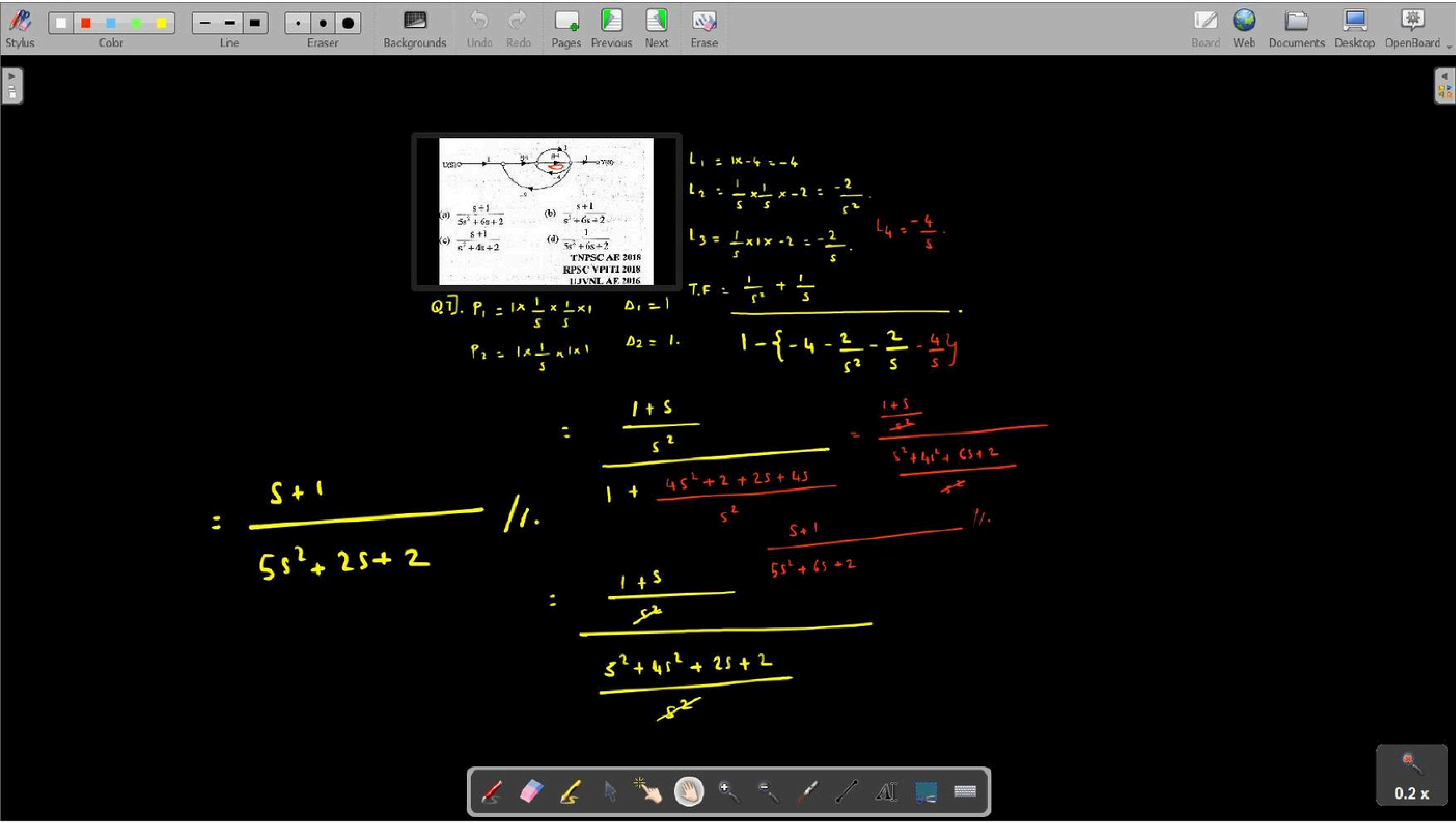
$P_2 = 1 \times \frac{1}{s} \times 1 \times 1$ $\Delta_2 = 1.$

$$T.F = \frac{\frac{1}{s^2} + \frac{1}{s}}{1 - \left\{ -4 - \frac{2}{s^2} - \frac{2}{s} - \frac{4}{s} \right\}}.$$

$$= \frac{\frac{1+s}{s^2}}{4s^2 + 2 + 2s + 4s}$$

$$= \frac{\frac{1+s}{\cancel{s^2}}}{\frac{s^2+4s^2+6s+2}{\cancel{s^2}}}$$

Full Video Link



(a) $\frac{s+1}{5s^2+6s+2}$ (b) $\frac{s+1}{s^2+6s+2}$

(c) $\frac{s+1}{s^2+4s+2}$ (d) $\frac{1}{5s^2+6s+2}$

TNPSC AE 2018
RPSC VPITI 2018
UJVNL AE 2016

Q7]. $P_1 = 1\times\frac{1}{s}\times\frac{1}{s}\times 1$ $\Delta_1 = 1$

$P_2 = 1\times\frac{1}{s}\times 1\times 1$ $\Delta_2 = 1.$

$L_1 = 1\times -4 = -4$

$L_2 = \frac{1}{s}\times\frac{1}{s}\times -2 = \frac{-2}{s^2}.$

$L_3 = \frac{1}{s}\times 1\times -2 = -\frac{2}{s}.$

$L_4 = \frac{-4}{s}.$

$$T.F = \frac{\frac{1}{s^2}+\frac{1}{s}}{1-\left\{-4-\frac{2}{s^2}-\frac{2}{s}-\frac{4}{s}\right\}}.$$

$$= \frac{\frac{1+s}{s^2}}{1+\frac{4s^2+2+2s+4s}{s^2}}$$

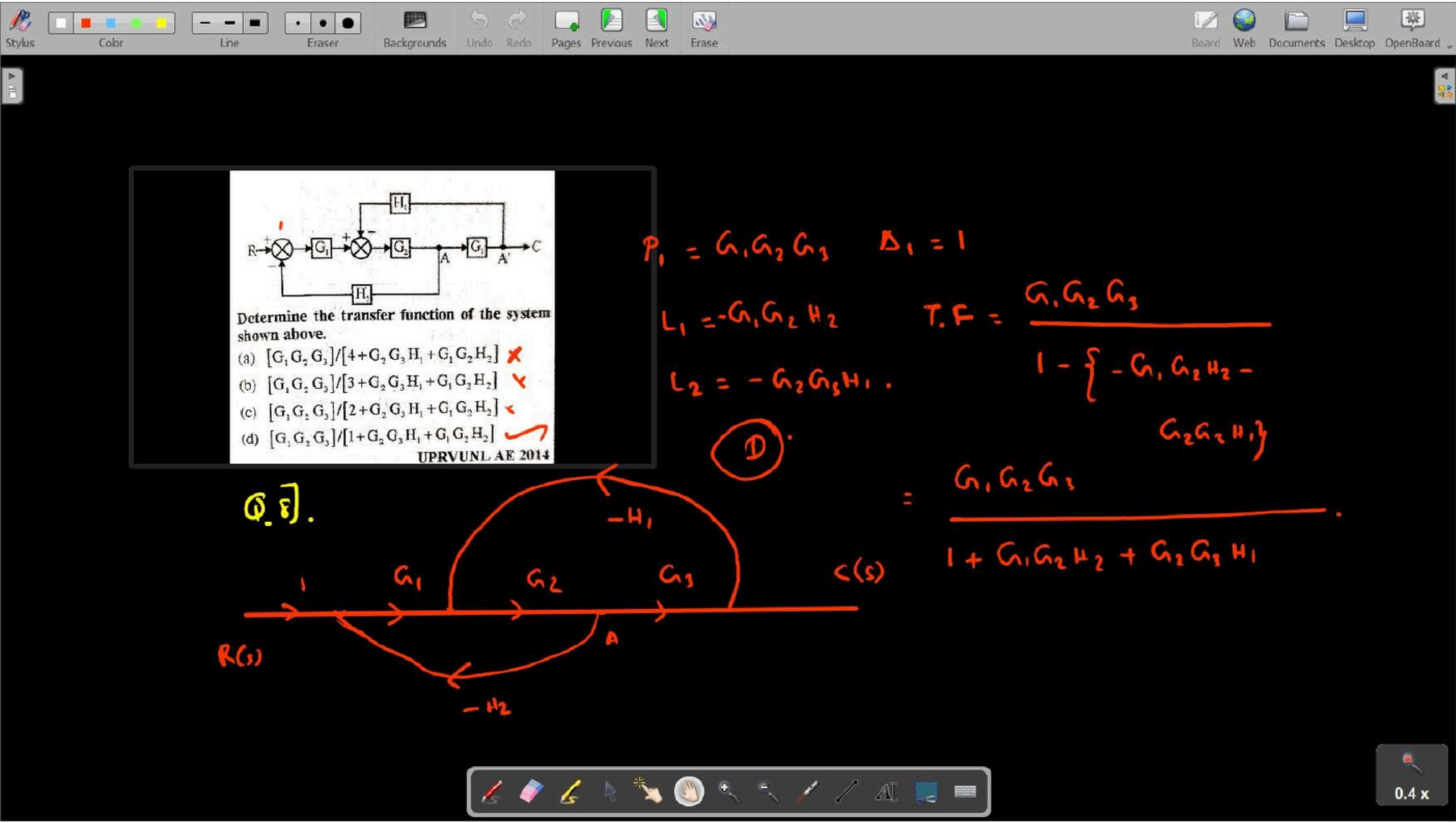
$$= \frac{\frac{1+s}{\cancel{s^2}}}{\frac{s^2+4s^2+2s+2}{\cancel{s^2}}}$$

$$= \frac{s+1}{5s^2+2s+2} \text{ //.}$$

$$= \frac{\frac{1+s}{\cancel{s^2}}}{\frac{s^2+4s^2+6s+2}{\cancel{s^2}}}$$

$$\frac{s+1}{5s^2+6s+2} \text{ //.}$$

Full Video Link



Determine the transfer function of the system shown above.

(a) $[G_1G_2G_3]/[4+G_2G_3H_1+G_1G_2H_2]$ ✗

(b) $[G_1G_2G_3]/[3+G_2G_3H_1+G_1G_2H_2]$ ✗

(c) $[G_1G_2G_3]/[2+G_2G_3H_1+G_1G_2H_2]$ ✗

(d) $[G_1G_2G_3]/[1+G_2G_3H_1+G_1G_2H_2]$ ✓

UPRVUNL AE 2014

Q.8.

$P_1 = G_1G_2G_3 \qquad \Delta_1 = 1$

$L_1 = -G_1G_2H_2$

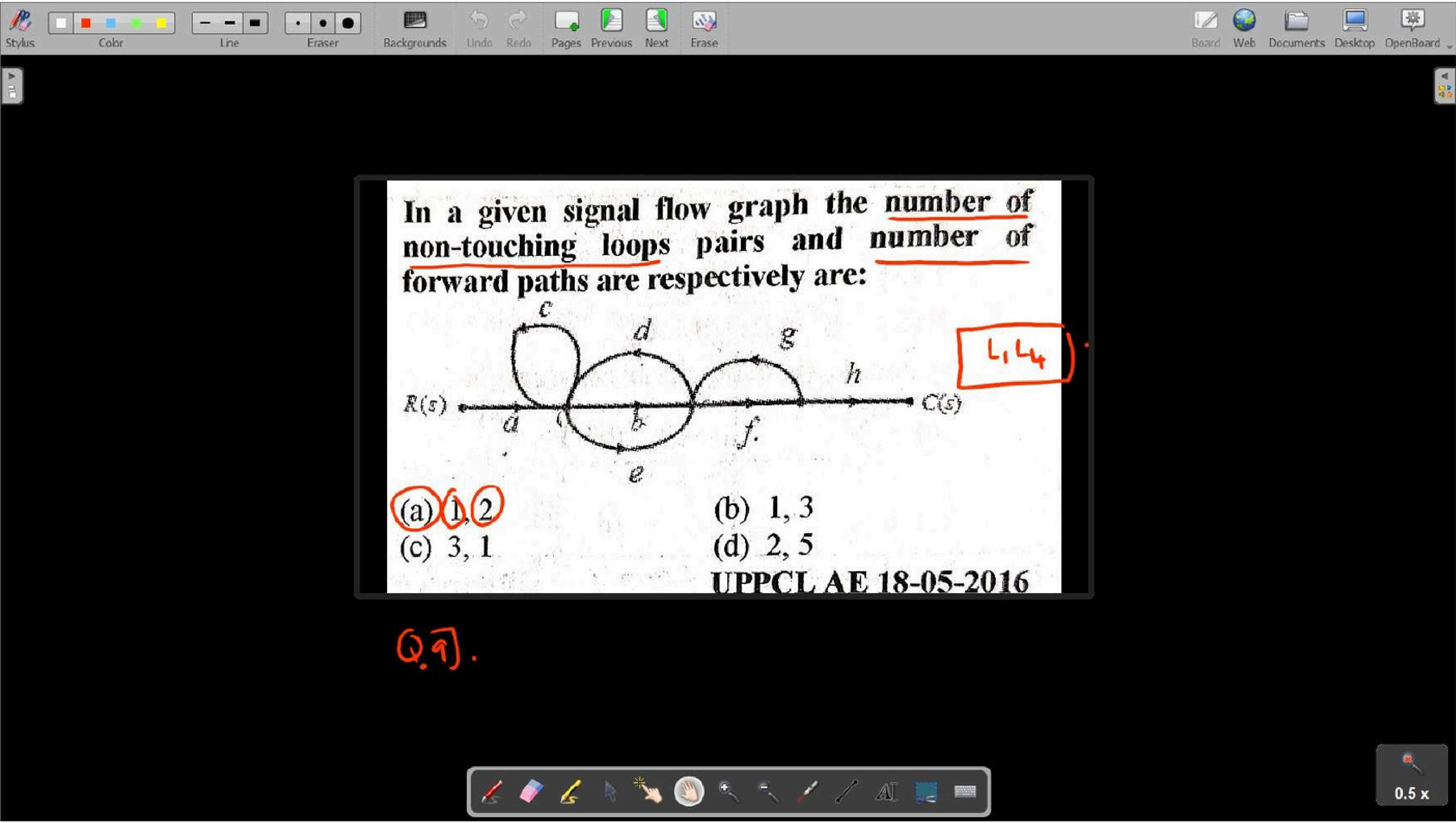
$L_2 = -G_2G_3H_1.$

$$T.F = \frac{G_1G_2G_3}{1-\{-G_1G_2H_2 - G_2G_3H_1\}}$$

$$= \frac{G_1G_2G_3}{1+G_1G_2H_2+G_2G_3H_1}.$$

Ⓓ.

Full Video Link



In a given signal flow graph the number of non-touching loops pairs and number of forward paths are respectively are:

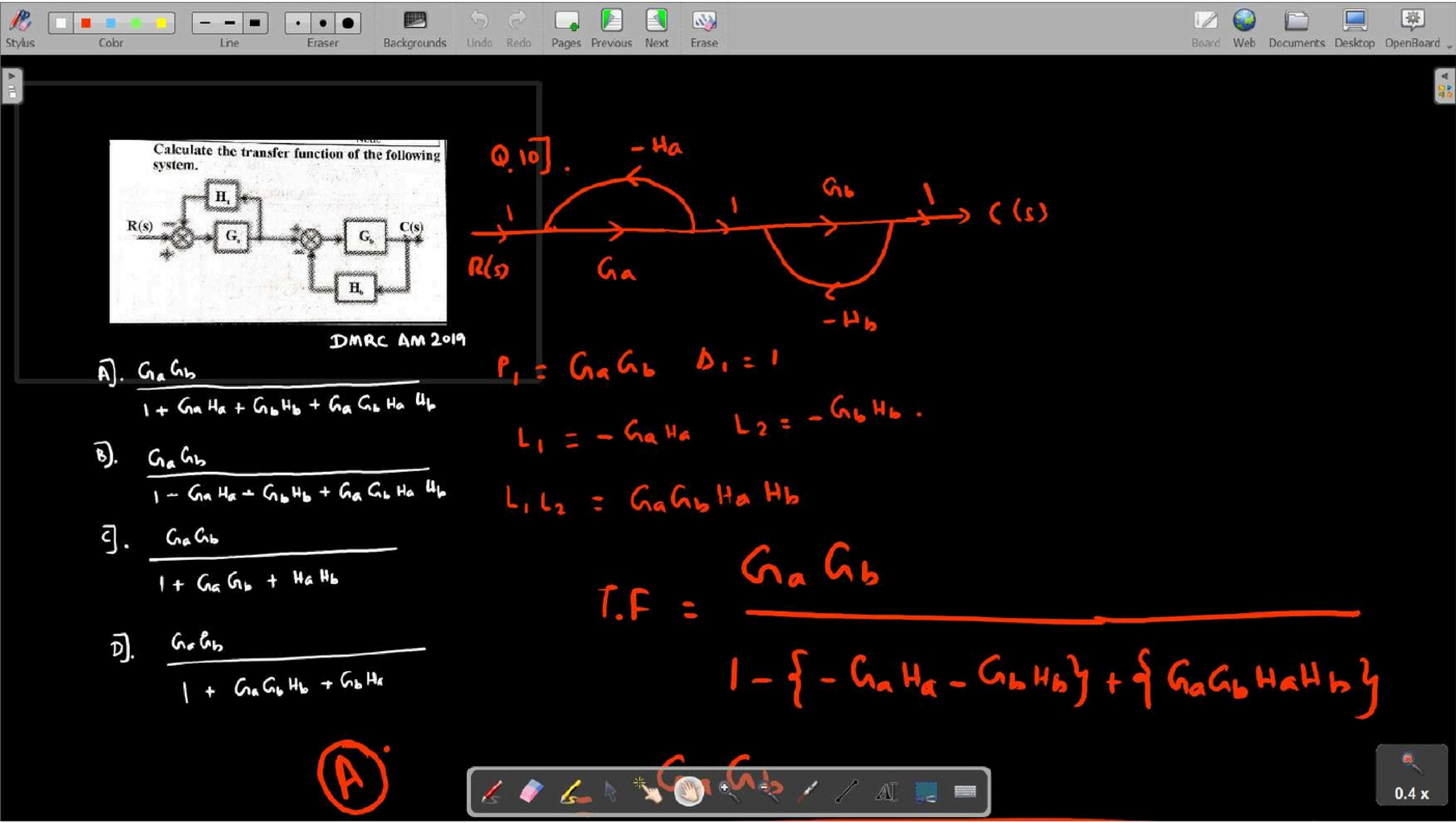
$L_1 L_4$

[✓ (a) 1, 2]
(b) 1, 3
(c) 3, 1
(d) 2, 5

UPPCL AE 18-05-2016

Q.9.

Full Video Link



Calculate the transfer function of the following system.

Q.10].

DMRC AM 2019

A). $\frac{G_aG_b}{1+G_aH_a+G_bH_b+G_aG_bH_aH_b}$

B). $\frac{G_aG_b}{1-G_aH_a+G_bH_b+G_aG_bH_aH_b}$

C]. $\frac{G_aG_b}{1+G_aG_b+H_aH_b}$

D]. $\frac{G_aG_b}{1+G_aG_bH_b+G_bH_a}$

$P_1 = G_aG_b \quad \Delta_1 = 1$

$L_1 = -G_aH_a \quad L_2 = -G_bH_b$.

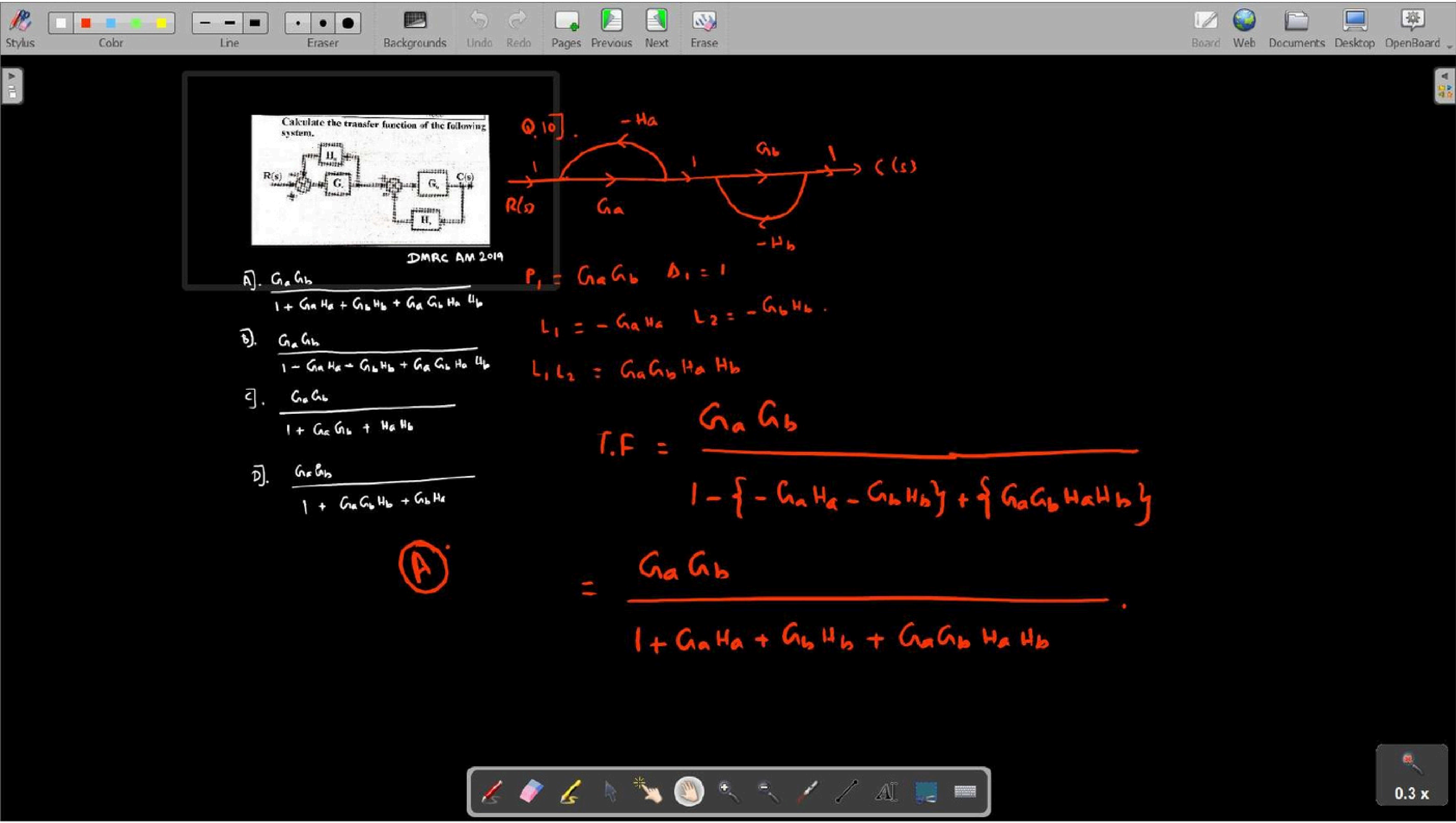
$L_1L_2 = G_aG_bH_aH_b$

$$T.F = \frac{G_aG_b}{1-\{-G_aH_a-G_bH_b\}+\{G_aG_bH_aH_b\}}$$

Ⓐ.

G_aG_b

Full Video Link



Calculate the transfer function of the following system.

DMRC AM 2019

A]. $\dfrac{G_a G_b}{1 + G_a H_a + G_b H_b + G_a G_b H_a H_b}$

B]. $\dfrac{G_a G_b}{1 - G_a H_a - G_b H_b + G_a G_b H_a H_b}$

C]. $\dfrac{G_a G_b}{1 + G_a G_b + H_a H_b}$

D]. $\dfrac{G_a G_b}{1 + G_a G_b H_b + G_b H_a}$

Ⓐ.

Q.10].

$P_1 = G_a G_b \quad \Delta_1 = 1$

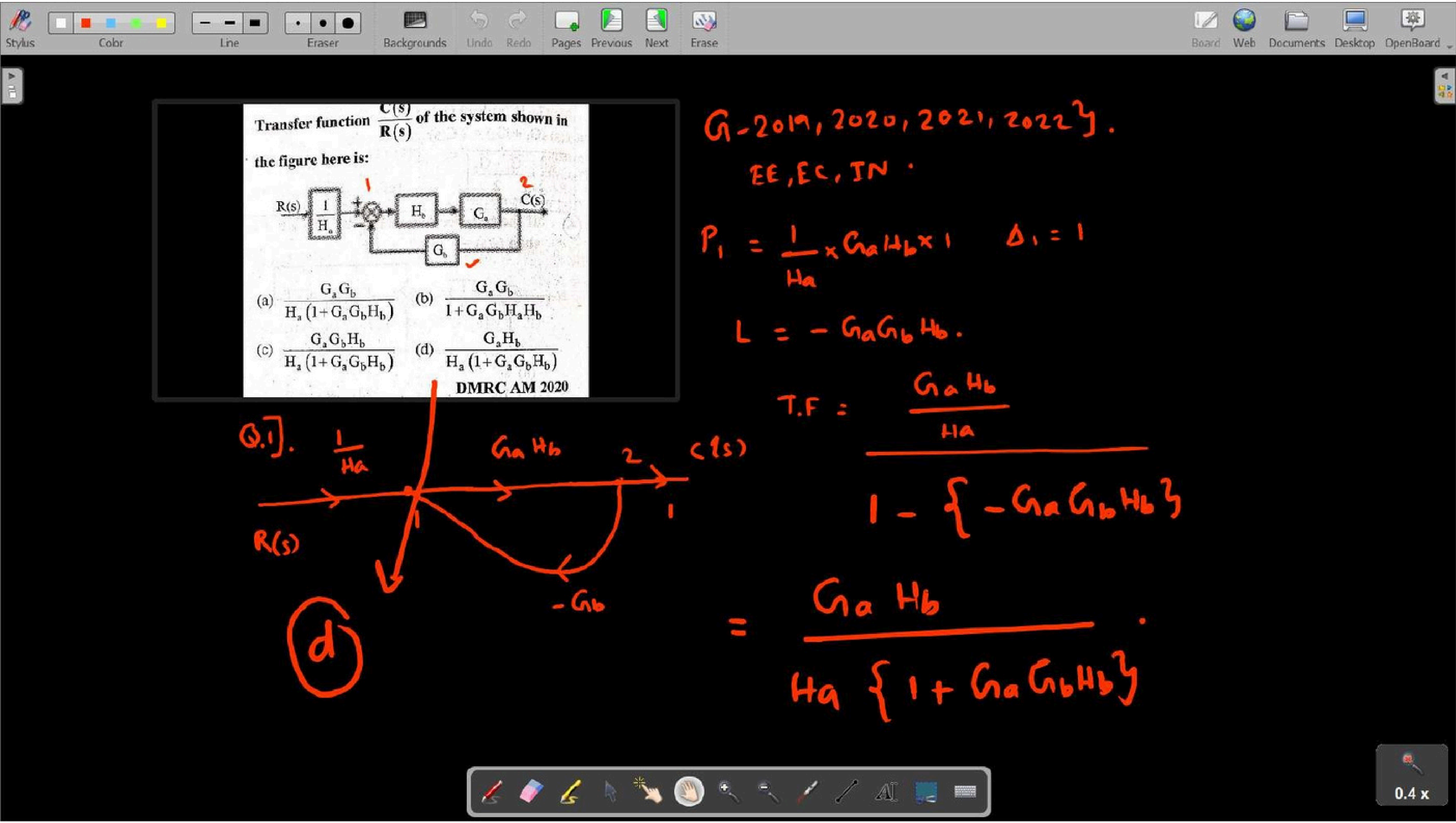
$L_1 = -G_a H_a \quad L_2 = -G_b H_b$.

$L_1 L_2 = G_a G_b H_a H_b$

$$T.F = \frac{G_a G_b}{1 - \{-G_a H_a - G_b H_b\} + \{G_a G_b H_a H_b\}}$$

$$= \frac{G_a G_b}{1 + G_a H_a + G_b H_b + G_a G_b H_a H_b}.$$

Full Video Link



Transfer function $\frac{C(s)}{R(s)}$ of the system shown in the figure here is:

(a) $\frac{G_aG_b}{H_a(1+G_aG_bH_b)}$ (b) $\frac{G_aG_b}{1+G_aG_bH_aH_b}$

(c) $\frac{G_aG_bH_b}{H_a(1+G_aG_bH_b)}$ (d) $\frac{G_aH_b}{H_a(1+G_aG_bH_b)}$

DMRC AM 2020

G-2019, 2020, 2021, 2022}.

EE, EC, IN.

$P_1 = \frac{1}{Ha} \times GaHb \times 1 \qquad \Delta_1 = 1$

$L = -GaGbHb.$

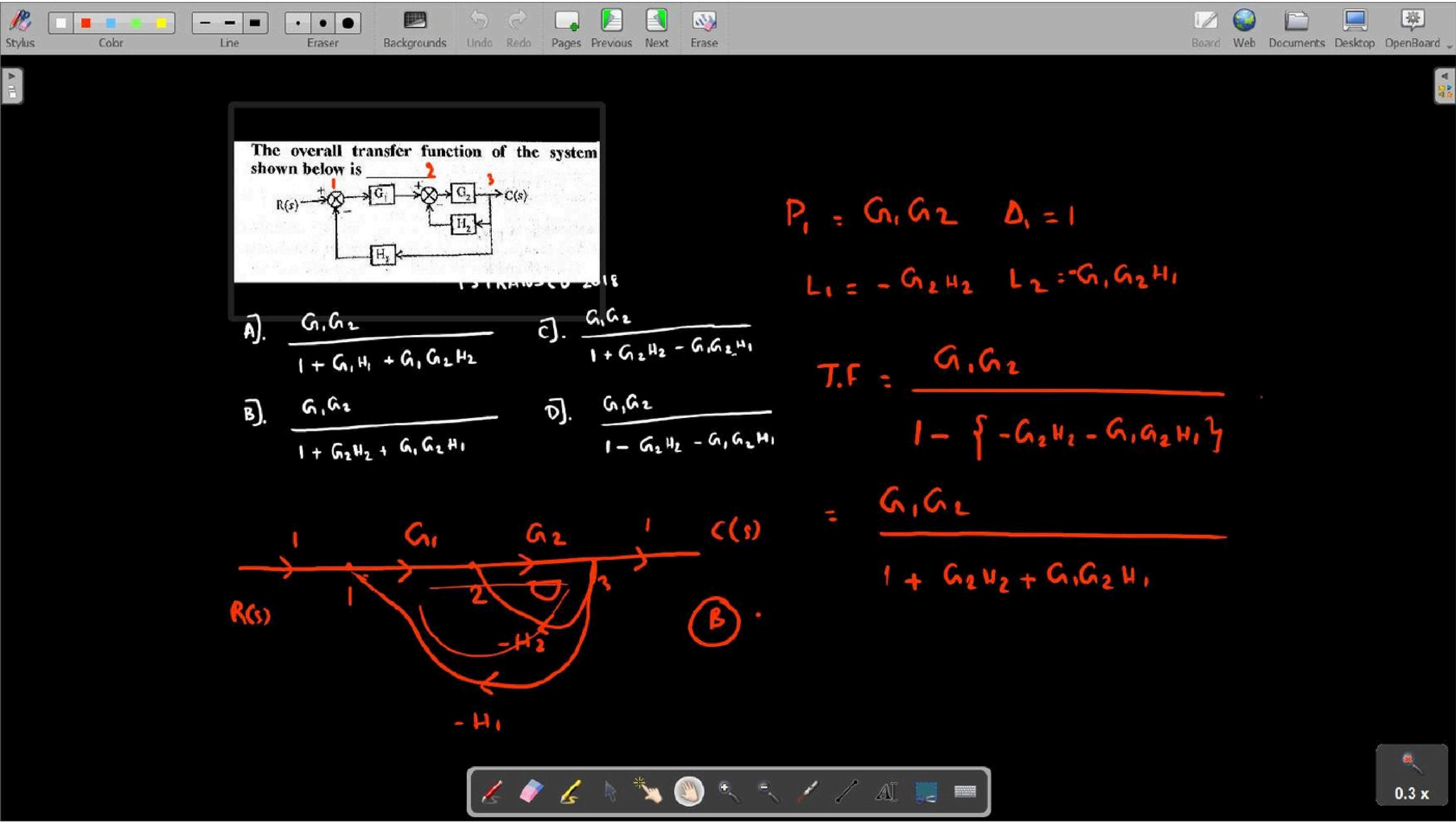
$$T.F = \frac{\frac{GaHb}{Ha}}{1-\{-GaGbHb\}}$$

$$= \frac{Ga\,Hb}{Ha\{1+GaGbHb\}}.$$

Q.1].

ⓓ

Full Video Link



The overall transfer function of the system shown below is ______

TS TRANSCO 2018

A). $\dfrac{G_1G_2}{1+G_1H_1+G_1G_2H_2}$

B). $\dfrac{G_1G_2}{1+G_2H_2+G_1G_2H_1}$

C). $\dfrac{G_1G_2}{1+G_2H_2-G_1G_2H_1}$

D). $\dfrac{G_1G_2}{1-G_2H_2-G_1G_2H_1}$

$P_1 = G_1G_2 \quad \Delta_1 = 1$

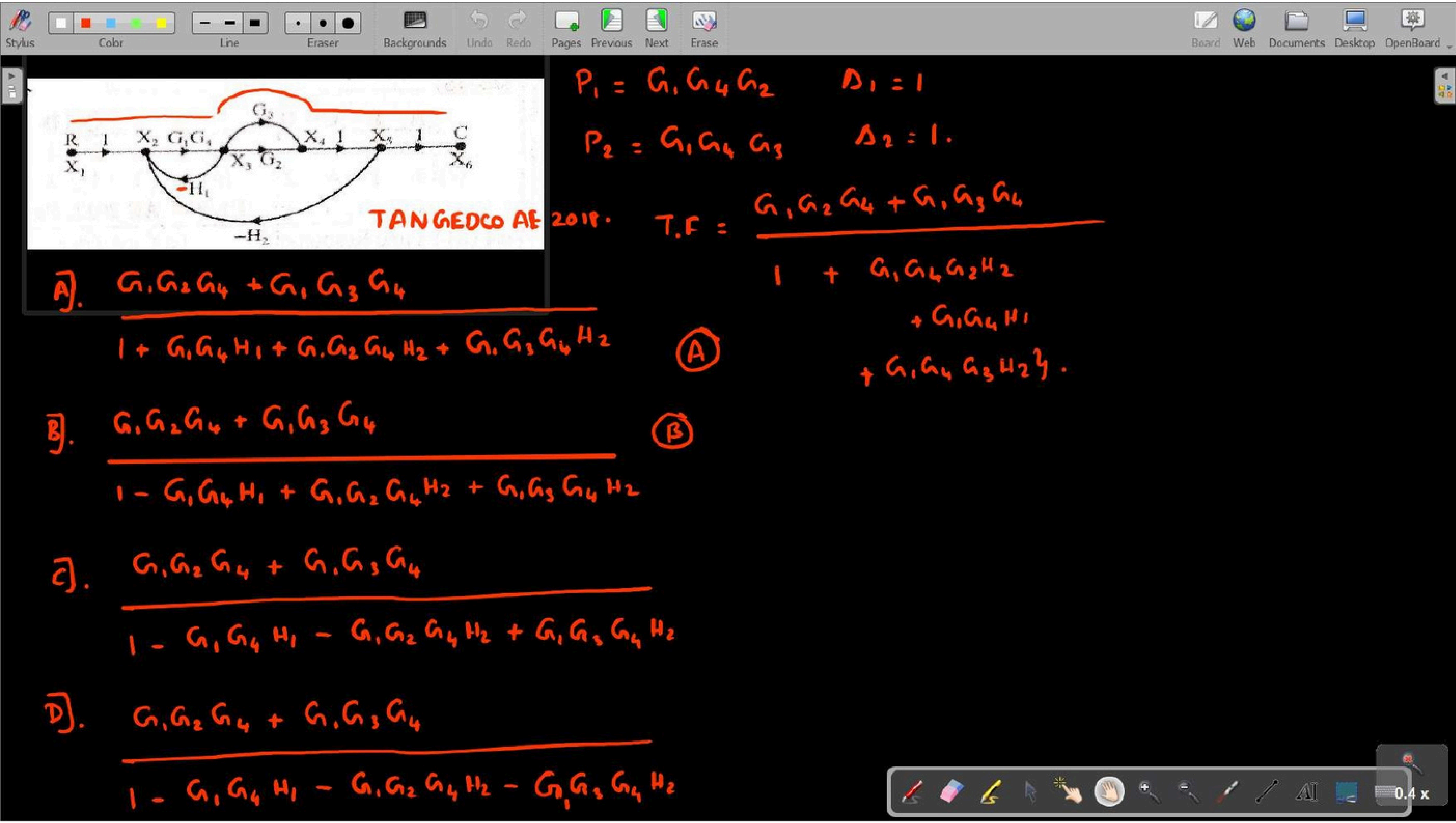
$L_1 = -G_2H_2 \quad L_2 = -G_1G_2H_1$

$$T.F = \frac{G_1G_2}{1-\{-G_2H_2-G_1G_2H_1\}}$$

$$= \frac{G_1G_2}{1+G_2H_2+G_1G_2H_1}$$

Ⓑ.

Full Video Link



TANGEDCO AE 2018.

$P_1 = G_1 G_4 G_2 \qquad \Delta_1 = 1$

$P_2 = G_1 G_4 G_3 \qquad \Delta_2 = 1.$

$$T.F = \frac{G_1G_2G_4 + G_1G_3G_4}{1 + G_1G_4G_2H_2 + G_1G_4H_1 + G_1G_4G_3H_2\}.}$$

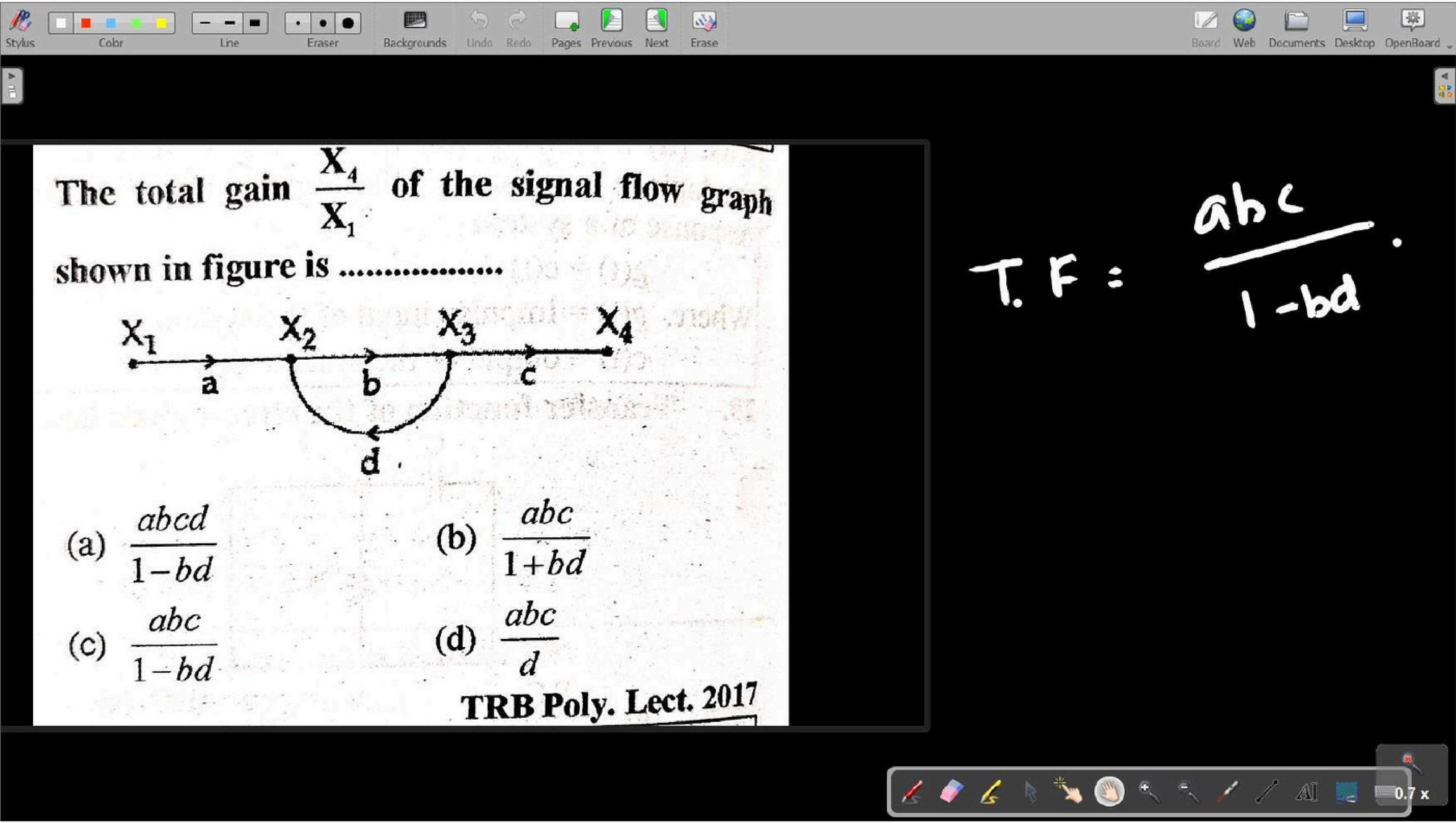
A]. $$\frac{G_1G_2G_4 + G_1G_3G_4}{1 + G_1G_4H_1 + G_1G_2G_4H_2 + G_1G_3G_4H_2}$$ Ⓐ

B]. $$\frac{G_1G_2G_4 + G_1G_3G_4}{1 - G_1G_4H_1 + G_1G_2G_4H_2 + G_1G_3G_4H_2}$$ Ⓑ

C]. $$\frac{G_1G_2G_4 + G_1G_3G_4}{1 - G_1G_4H_1 - G_1G_2G_4H_2 + G_1G_3G_4H_2}$$

D]. $$\frac{G_1G_2G_4 + G_1G_3G_4}{1 - G_1G_4H_1 - G_1G_2G_4H_2 - G_1G_3G_4H_2}$$

Full Video Link



The total gain $\frac{X_4}{X_1}$ of the signal flow graph shown in figure is ....

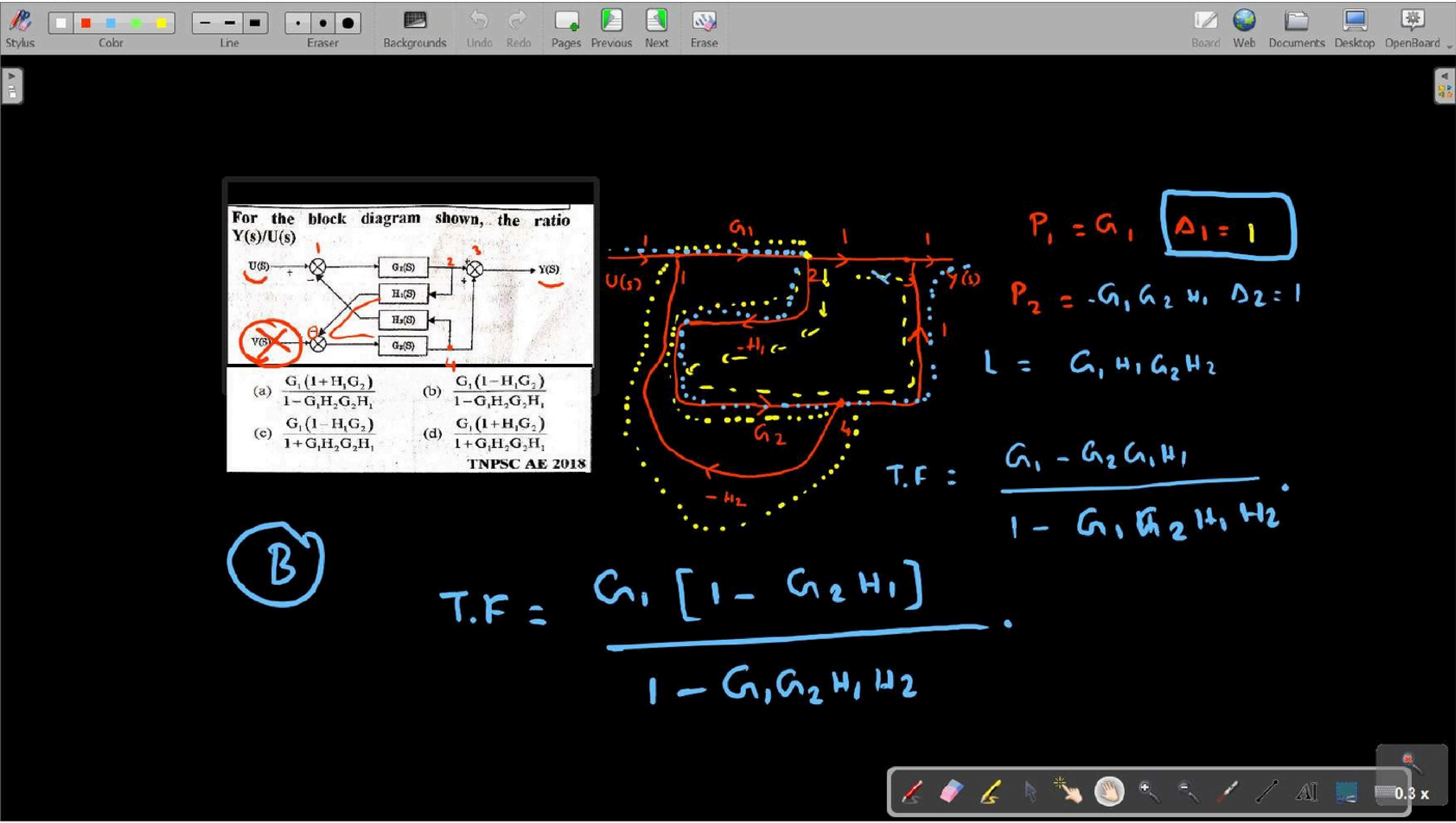
(a) $\frac{abcd}{1-bd}$ (b) $\frac{abc}{1+bd}$

(c) $\frac{abc}{1-bd}$ (d) $\frac{abc}{d}$

TRB Poly. Lect. 2017

$$T.F = \frac{abc}{1-bd}.$$

Full Video Link



For the block diagram shown, the ratio Y(s)/U(s)

(a) $\frac{G_1(1+H_1G_2)}{1-G_1H_2G_2H_1}$ (b) $\frac{G_1(1-H_1G_2)}{1-G_1H_2G_2H_1}$

(c) $\frac{G_1(1-H_1G_2)}{1+G_1H_2G_2H_1}$ (d) $\frac{G_1(1+H_1G_2)}{1+G_1H_2G_2H_1}$

TNPSC AE 2018

$P_1 = G_1$ $\boxed{\Delta_1 = 1}$

$P_2 = -G_1G_2H_1$ $\Delta_2 = 1$

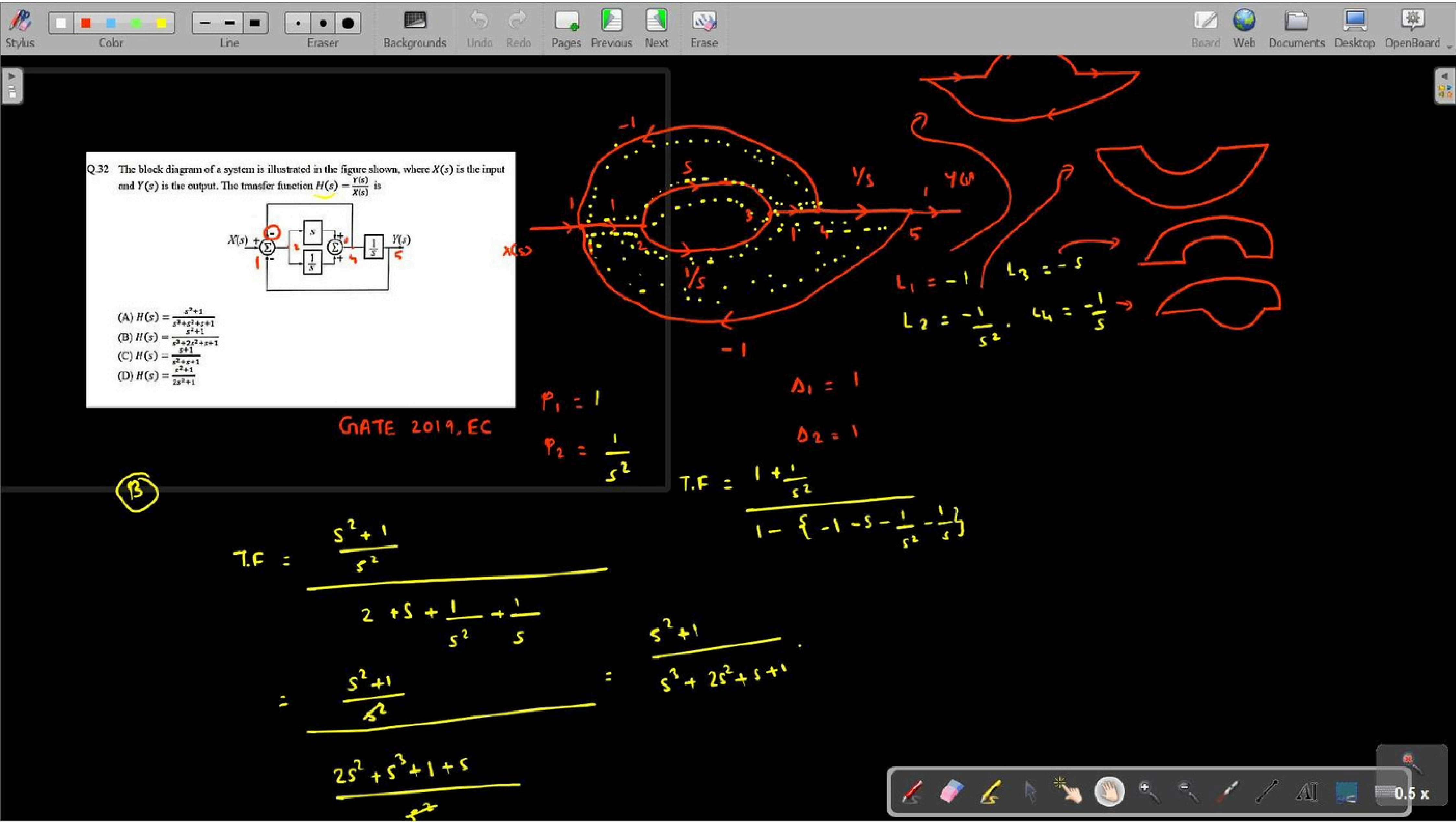
$L = G_1H_1G_2H_2$

$$T.F = \frac{G_1 - G_2G_1H_1}{1 - G_1G_2H_1H_2}.$$

Ⓑ

$$T.F = \frac{G_1[1 - G_2H_1]}{1 - G_1G_2H_1H_2}.$$

Full Video Link



Q.32 The block diagram of a system is illustrated in the figure shown, where $X(s)$ is the input and $Y(s)$ is the output. The transfer function $H(s) = \frac{Y(s)}{X(s)}$ is

(A) $H(s) = \frac{s^2+1}{s^3+s^2+s+1}$

(B) $H(s) = \frac{s^2+1}{s^3+2s^2+s+1}$

(C) $H(s) = \frac{s+1}{s^2+s+1}$

(D) $H(s) = \frac{s^2+1}{2s^2+1}$

GATE 2019, EC

$L_1 = -1$ $L_3 = -s$

$L_2 = -\frac{1}{s^2}$, $L_4 = -\frac{1}{s}$

$P_1 = 1$

$P_2 = \frac{1}{s^2}$

$\Delta_1 = 1$

$\Delta_2 = 1$

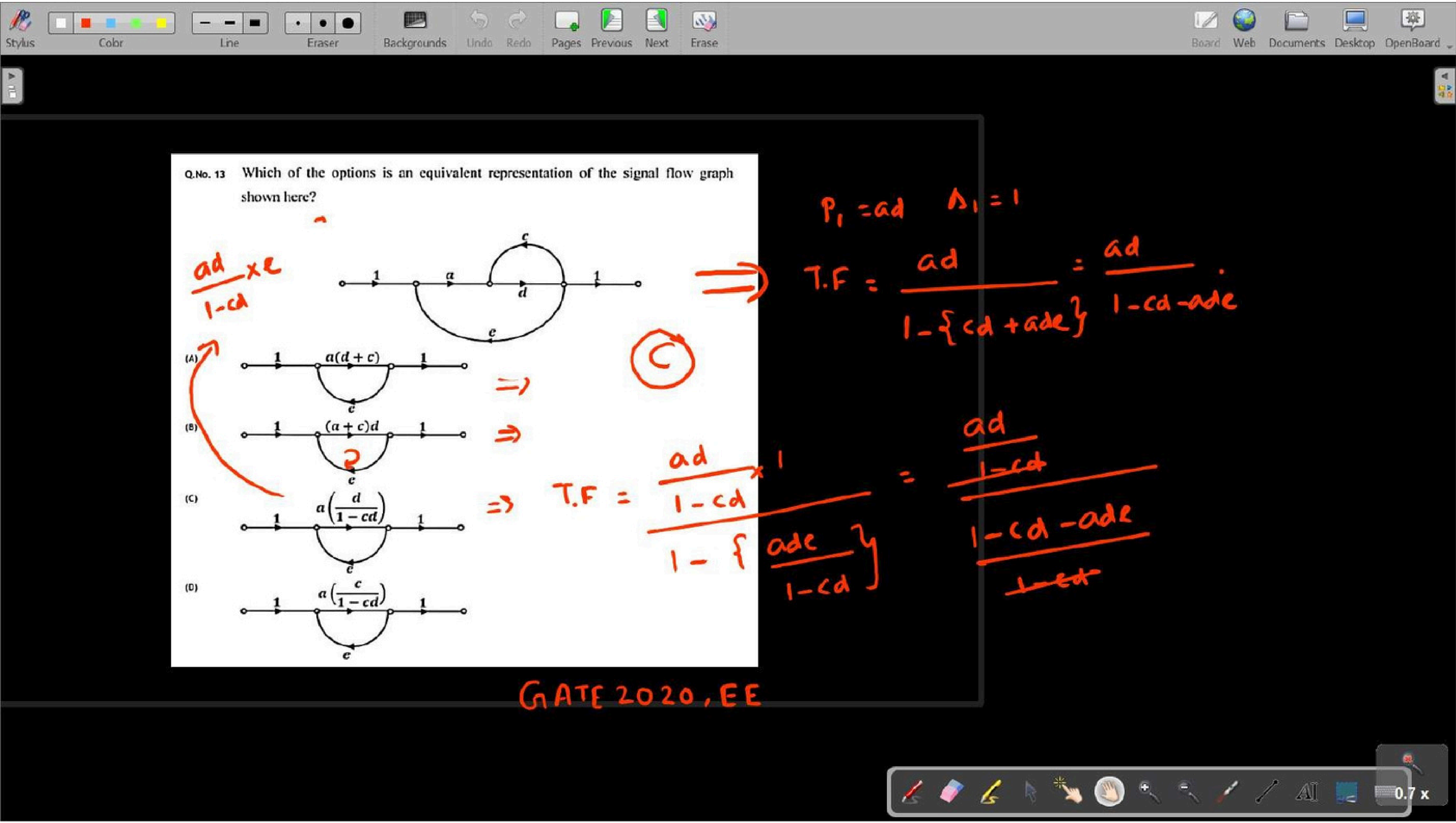
$$T.F = \frac{1 + \frac{1}{s^2}}{1 - \{-1 - s - \frac{1}{s^2} - \frac{1}{s}\}}$$

(B)

$$T.F = \frac{\frac{s^2+1}{s^2}}{2 + s + \frac{1}{s^2} + \frac{1}{s}}$$

$$= \frac{\frac{s^2+1}{s^2}}{\frac{2s^2+s^3+1+s}{s^2}} = \frac{s^2+1}{s^3+2s^2+s+1}.$$

Full Video Link



Q.No. 13 Which of the options is an equivalent representation of the signal flow graph shown here?

$\frac{ad}{1-cd} \times e$

$P_1 = ad \quad \Delta_1 = 1$

$\Rightarrow \quad T.F = \frac{ad}{1-\{cd+ade\}} = \frac{ad}{1-cd-ade}$.

$\boxed{C}$

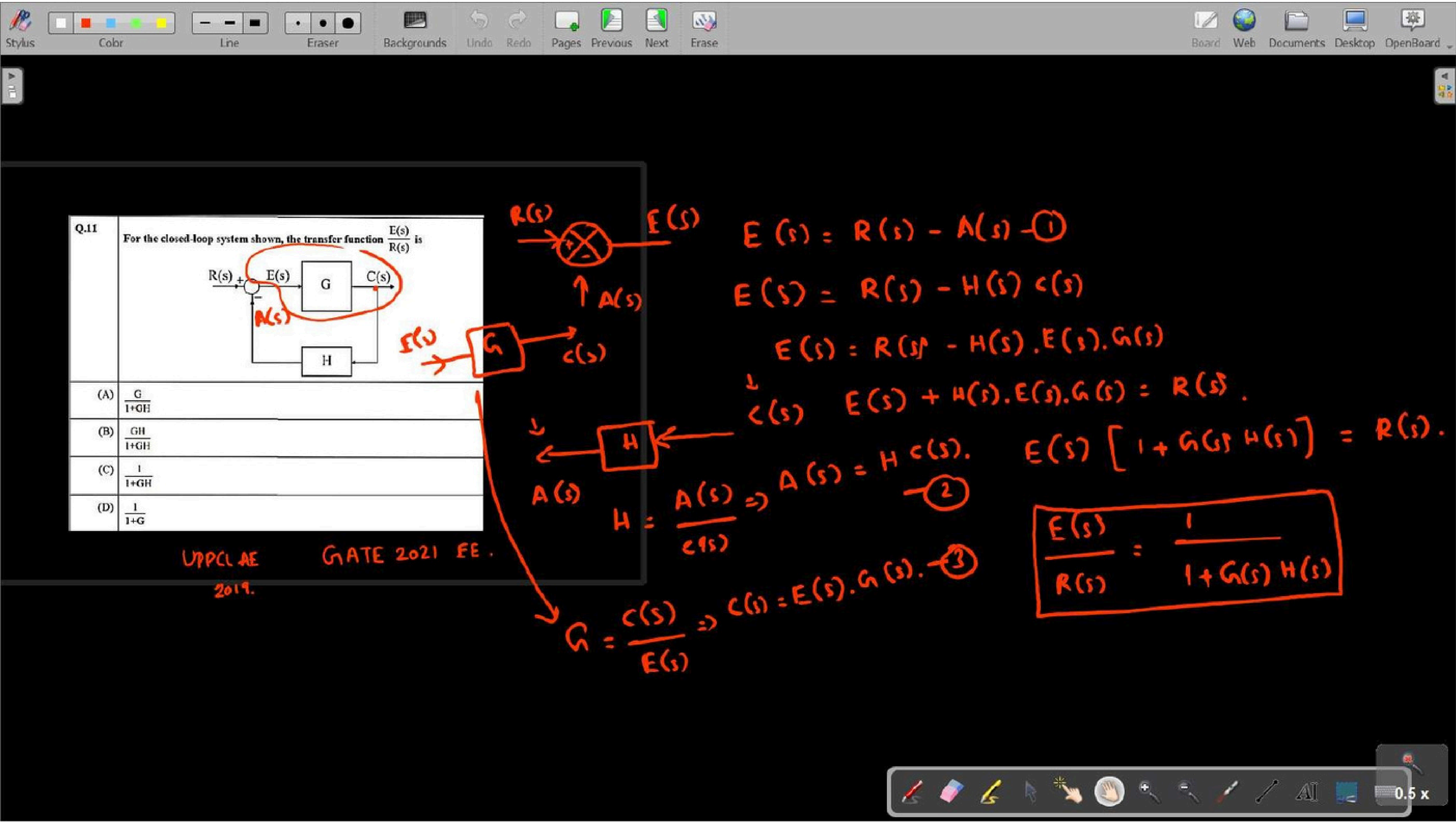
$\Rightarrow$

$\Rightarrow$

$\Rightarrow \quad T.F = \frac{\frac{ad}{1-cd} \times 1}{1-\left\{\frac{ade}{1-cd}\right\}} = \frac{\frac{ad}{\cancel{1-cd}}}{\frac{1-cd-ade}{\cancel{1-cd}}}$

GATE 2020, EE

Full Video Link



Q.11 For the closed-loop system shown, the transfer function $\frac{E(s)}{R(s)}$ is

(A)	$\frac{G}{1+GH}$
(B)	$\frac{GH}{1+GH}$
(C)	$\frac{1}{1+GH}$
(D)	$\frac{1}{1+G}$

UPPCL AE
2019.

GATE 2021 EE.

$E(s) = R(s) - A(s)$ — ①

$E(s) = R(s) - H(s)\,c(s)$

$E(s) = R(s) - H(s).E(s).G(s)$

$E(s) + H(s).E(s).G(s) = R(s).$

$E(s)\left[1 + G(s)\,H(s)\right] = R(s).$

$$\boxed{\frac{E(s)}{R(s)} = \frac{1}{1+G(s)\,H(s)}}$$

$H = \frac{A(s)}{c(s)} \Rightarrow A(s) = H\,c(s).$ — ②

$G = \frac{c(s)}{E(s)} \Rightarrow c(s) = E(s).G(s).$ — ③

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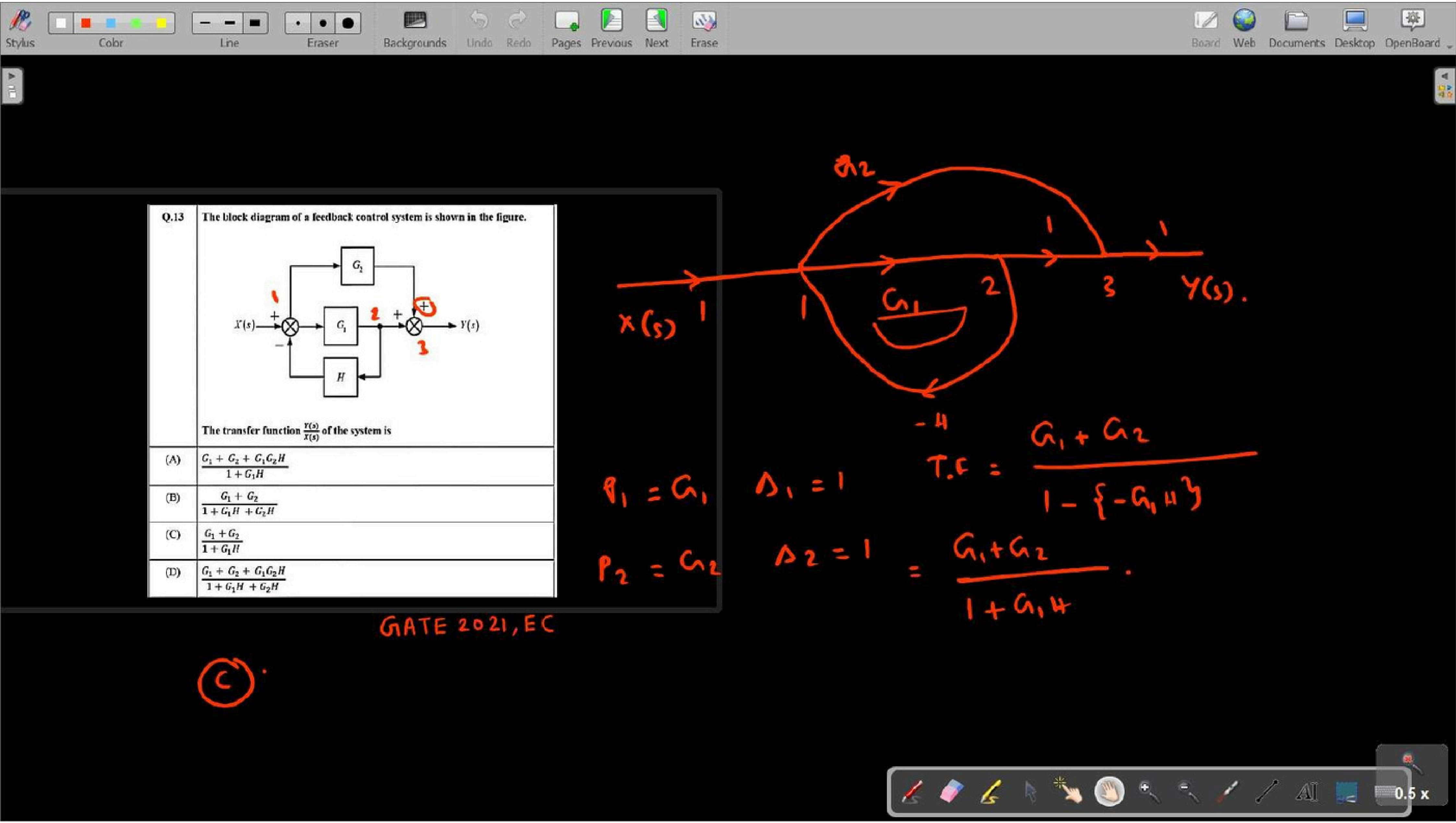


Q.13 The block diagram of a feedback control system is shown in the figure.

The transfer function $\frac{Y(s)}{X(s)}$ of the system is

(A) $\frac{G_1 + G_2 + G_1G_2H}{1 + G_1H}$

(B) $\frac{G_1 + G_2}{1 + G_1H + G_2H}$

(C) $\frac{G_1 + G_2}{1 + G_1H}$

(D) $\frac{G_1 + G_2 + G_1G_2H}{1 + G_1H + G_2H}$

GATE 2021, EC

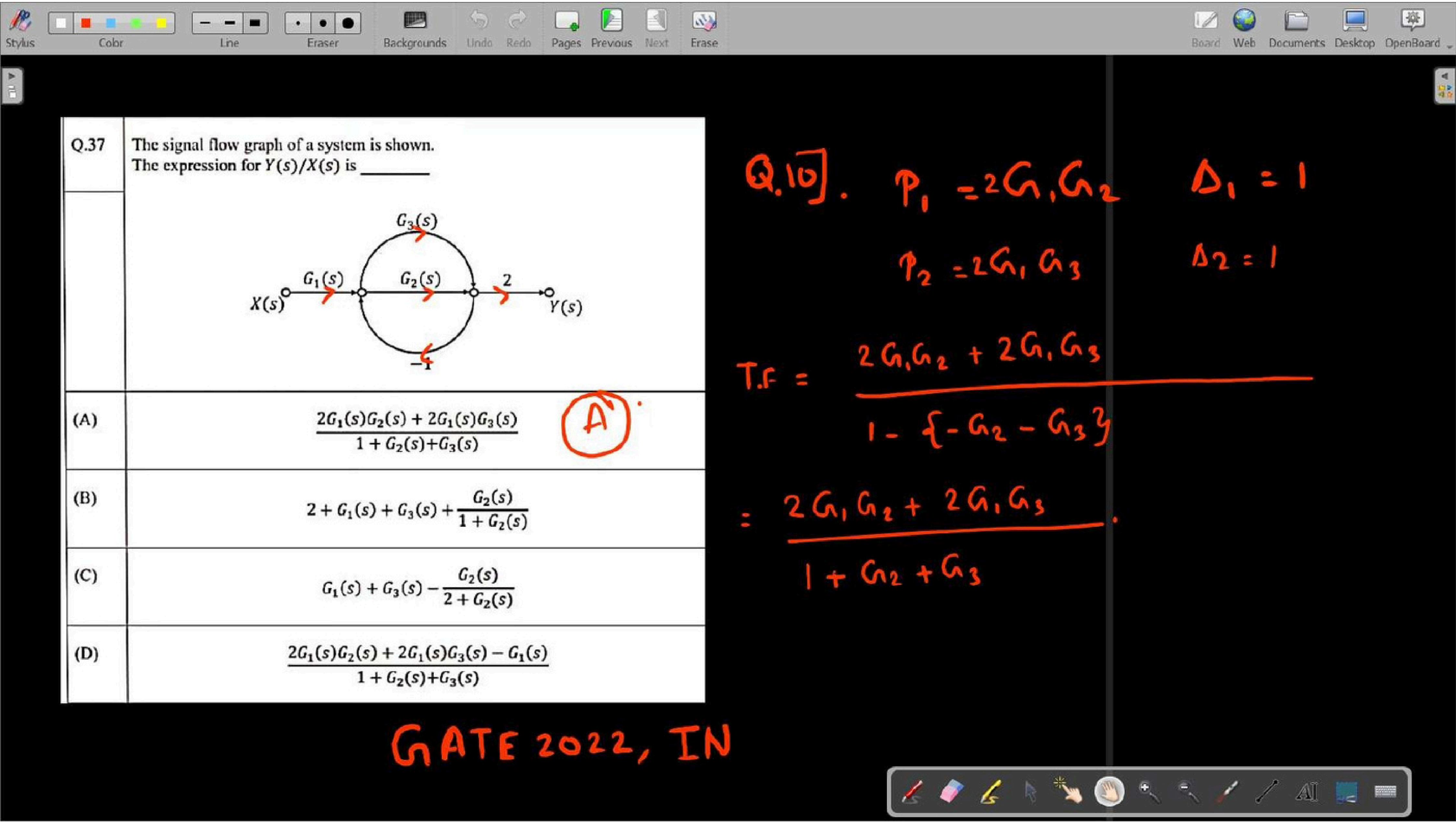
$P_1 = G_1 \quad \Delta_1 = 1$

$P_2 = G_2 \quad \Delta_2 = 1$

$$T.F = \frac{G_1 + G_2}{1 - \{-G_1H\}} = \frac{G_1 + G_2}{1 + G_1H}.$$

Ⓒ.

Full Video Link



Q.37 The signal flow graph of a system is shown. The expression for $Y(s)/X(s)$ is ________

(A) $\frac{2G_1(s)G_2(s)+2G_1(s)G_3(s)}{1+G_2(s)+G_3(s)}$ $\boxed{A}$

(B) $2+G_1(s)+G_3(s)+\frac{G_2(s)}{1+G_2(s)}$

(C) $G_1(s)+G_3(s)-\frac{G_2(s)}{2+G_2(s)}$

(D) $\frac{2G_1(s)G_2(s)+2G_1(s)G_3(s)-G_1(s)}{1+G_2(s)+G_3(s)}$

GATE 2022, IN

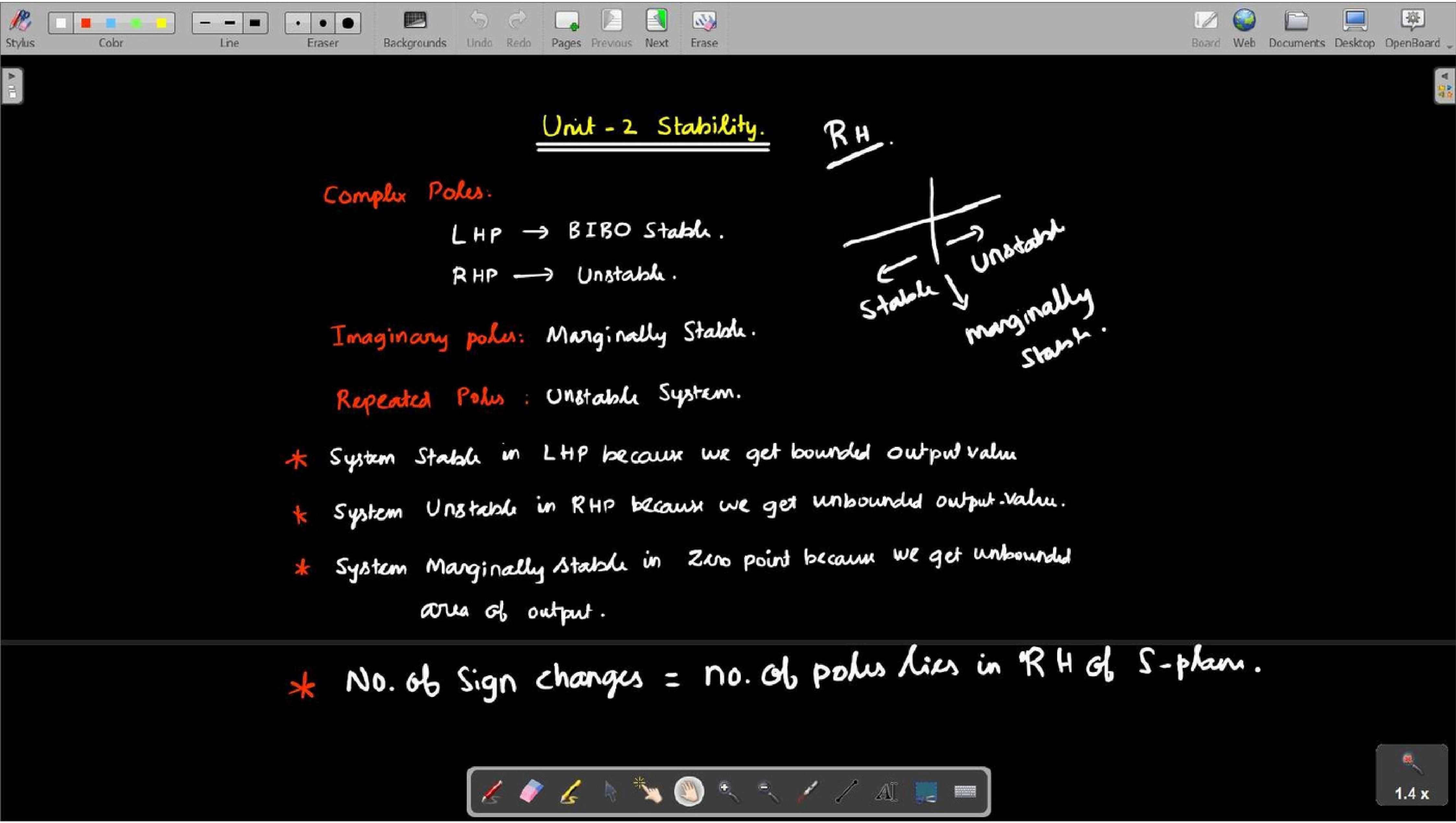
Q.10]. $P_1 = 2G_1G_2$ $\Delta_1 = 1$

$P_2 = 2G_1G_3$ $\Delta_2 = 1$

$$T.F = \frac{2G_1G_2 + 2G_1G_3}{1-\{-G_2-G_3\}}$$

$$= \frac{2G_1G_2 + 2G_1G_3}{1+G_2+G_3}.$$

Full Video Link



Unit - 2 Stability.

RH.

Complex Poles.

LHP → BIBO Stable.

RHP ⟶ Unstable.

Imaginary poles: Marginally Stable.

Repeated Poles : Unstable System.

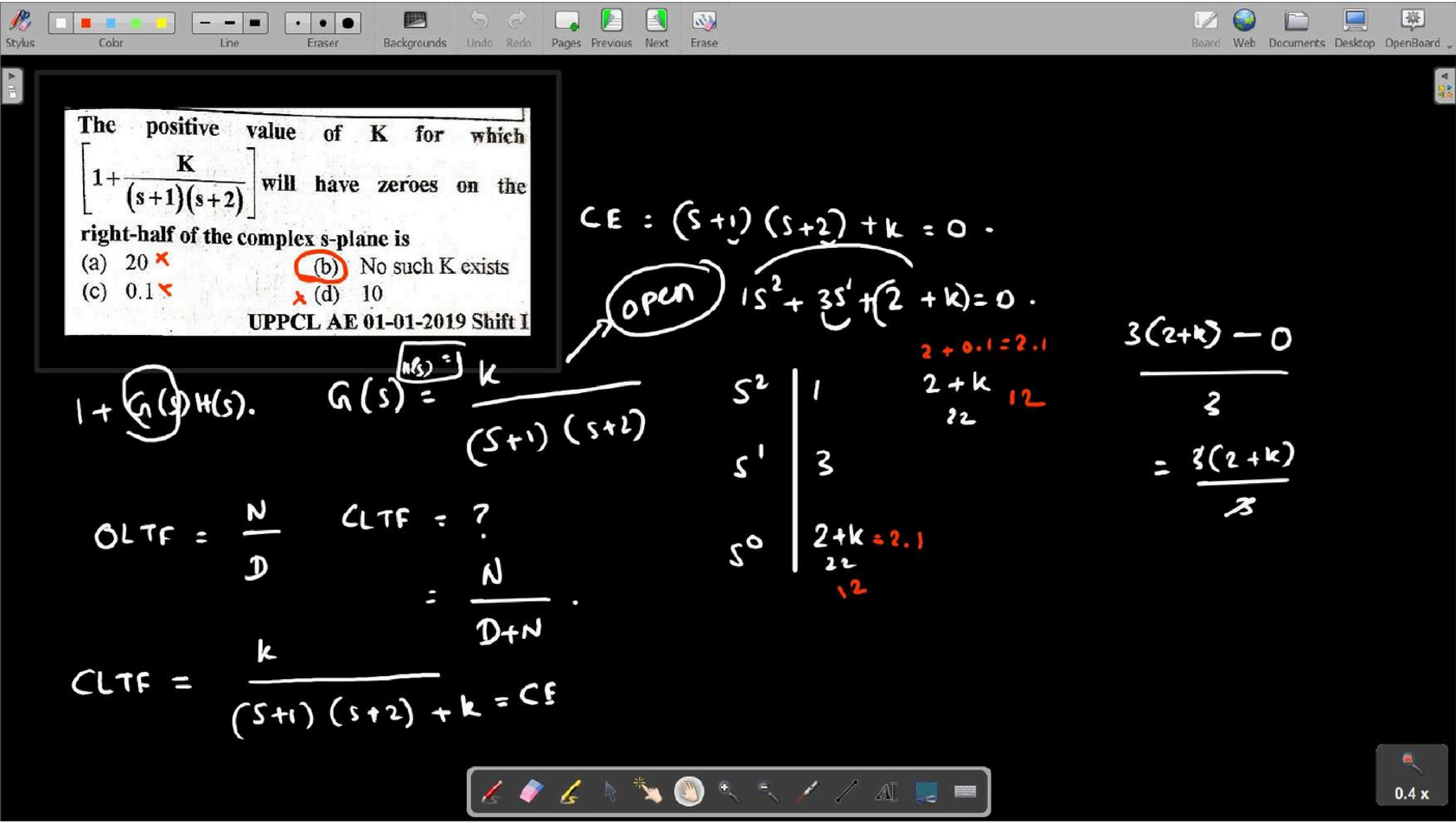
* System Stable in LHP because we get bounded output value

* System Unstable in RHP because we get unbounded output value.

* System Marginally Stable in Zero point because we get unbounded area of output.

* No. of Sign changes = no. of poles lies in RH of S-plane.

Full Video Link



The positive value of K for which $\left[1+\frac{K}{(s+1)(s+2)}\right]$ will have zeroes on the right-half of the complex s-plane is

(a) 20 × [✓ (b) No such K exists]

(c) 0.1 × × (d) 10

UPPCL AE 01-01-2019 Shift I

$1 + \bigcirc\!\!\!\!G(s)\,H(s).$

$\boxed{H(s) = 1}$

$G(s) = \frac{k}{(s+1)(s+2)}$ → open

$OLTF = \frac{N}{D}$ $CLTF = ?$

$= \frac{N}{D+N}.$

$CLTF = \frac{k}{(s+1)(s+2) + k = CE}$

$CE : (s+1)(s+2) + k = 0.$

$1s^2 + 3s^1 + (2 + k) = 0.$

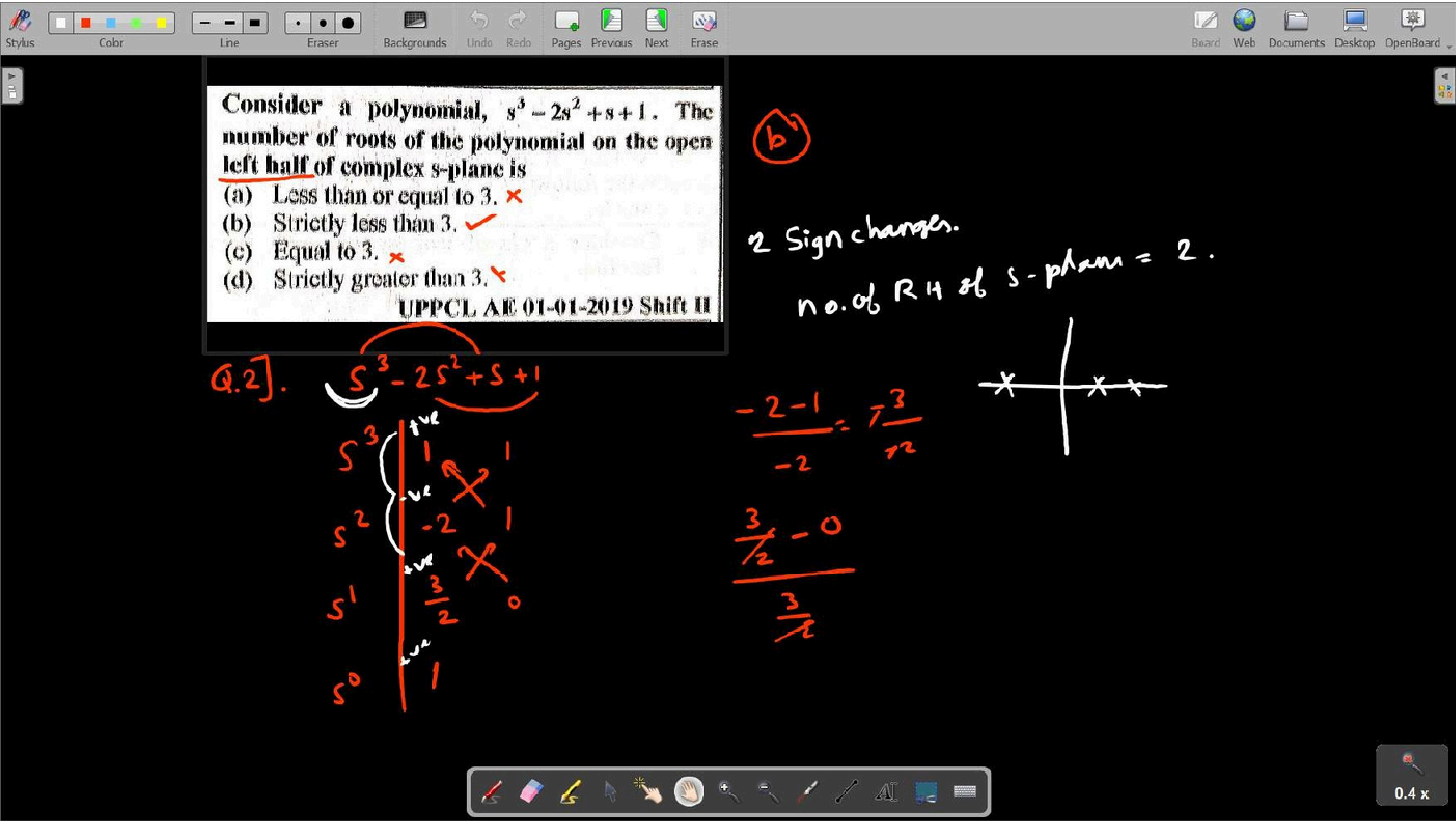
$2 + 0.1 = 2.1$

s^2	1	$2+k$ 22 12
s^1	3	
s^0	$2+k = 2.1$ 22 12	

$\frac{3(2+k) - 0}{3}$

$= \frac{3(2+k)}{\cancel{3}}$

Full Video Link



Consider a polynomial, s^3-2s^2+s+1. The number of roots of the polynomial on the open left half of complex s-plane is

(a) Less than or equal to 3. ×
(b) Strictly less than 3. ✓
(c) Equal to 3. ×
(d) Strictly greater than 3. ×

UPPCL AE 01-01-2019 Shift II

(b)

Q.2]. s^3-2s^2+s+1

s^3	1	1
s^2	-2	1
s^1	$\frac{3}{2}$	0
s^0	1	

+ve, -ve, +ve, +ve

$$\frac{-2-1}{-2}=\frac{\cancel{-}3}{\cancel{-}2}$$

$$\frac{\frac{3}{2}-0}{\frac{3}{2}}$$

2 Sign changes.

no. of RH of s-plane = 2.

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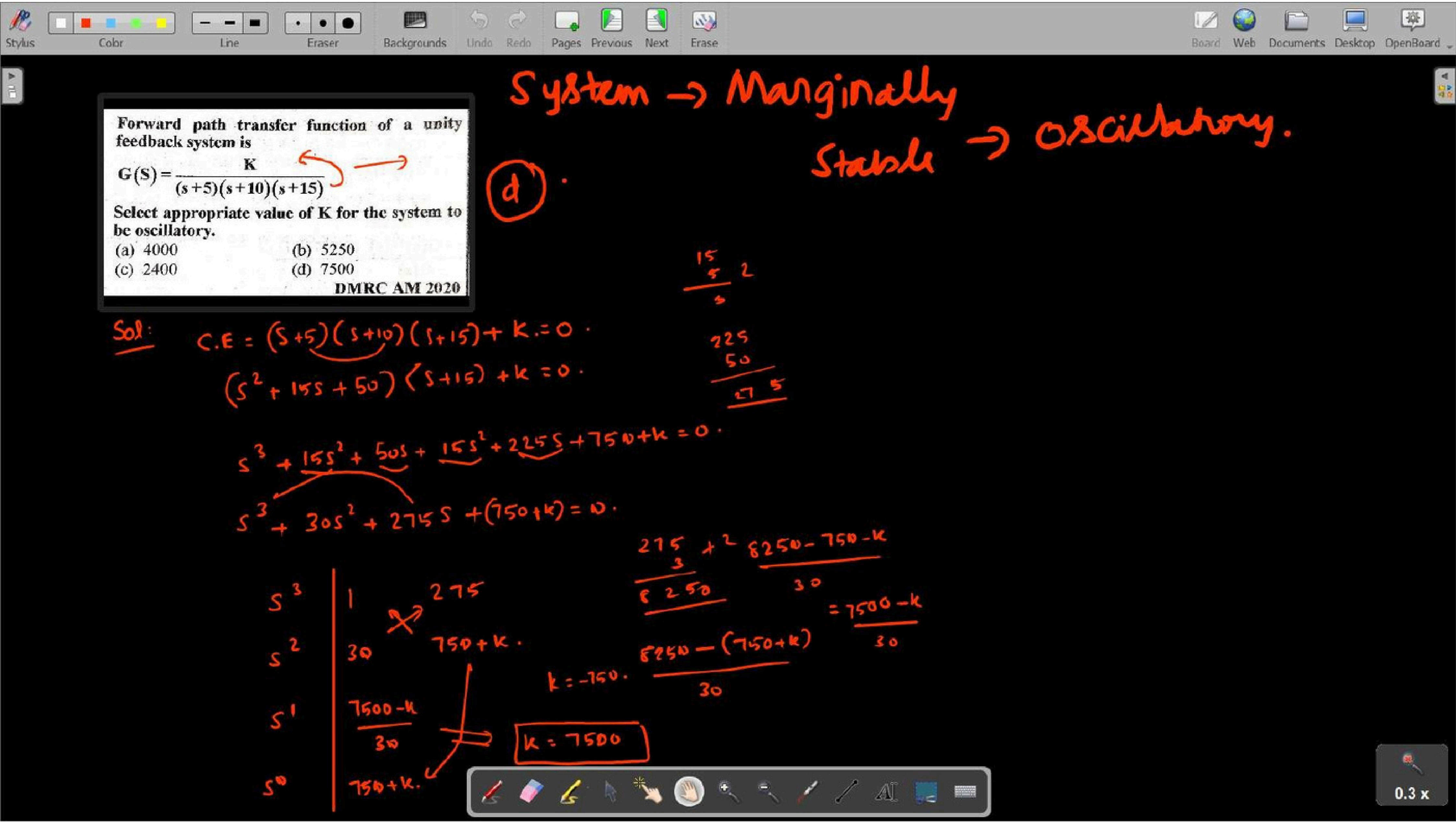

Forward path transfer function of a unity feedback system is

$$G(S) = \frac{K}{(s+5)(s+10)(s+15)}$$

Select appropriate value of K for the system to be oscillatory.

(a) 4000 (b) 5250
(c) 2400 (d) 7500

DMRC AM 2020

System → Marginally Stable → oscillatory.

$\boxed{d}$.

Sol:

$C.E = (S+5)(s+10)(s+15)+K = 0.$

$(s^2+15s+50)(s+15)+k=0.$

$s^3+15s^2+50s+15s^2+225s+750+k=0.$

$s^3+30s^2+275s+(750+k)=0.$

$\begin{array}{r} 15 \\ 5 \\ \hline 3 \end{array}$ 2

$\begin{array}{r} 225 \\ 50 \\ \hline 275 \end{array}$

$\begin{array}{r} 275 \\ 3 \\ \hline 8250 \end{array}$ $\times^2$

$\frac{8250-750-k}{30}$

$=\frac{7500-k}{30}$

$\frac{8250-(750+k)}{30}$

s^3	1	275
s^2	30	750+k.
s^1	$\frac{7500-k}{30}$	
s^0	750+k.	

$k=-750.$

$\boxed{k=7500}$

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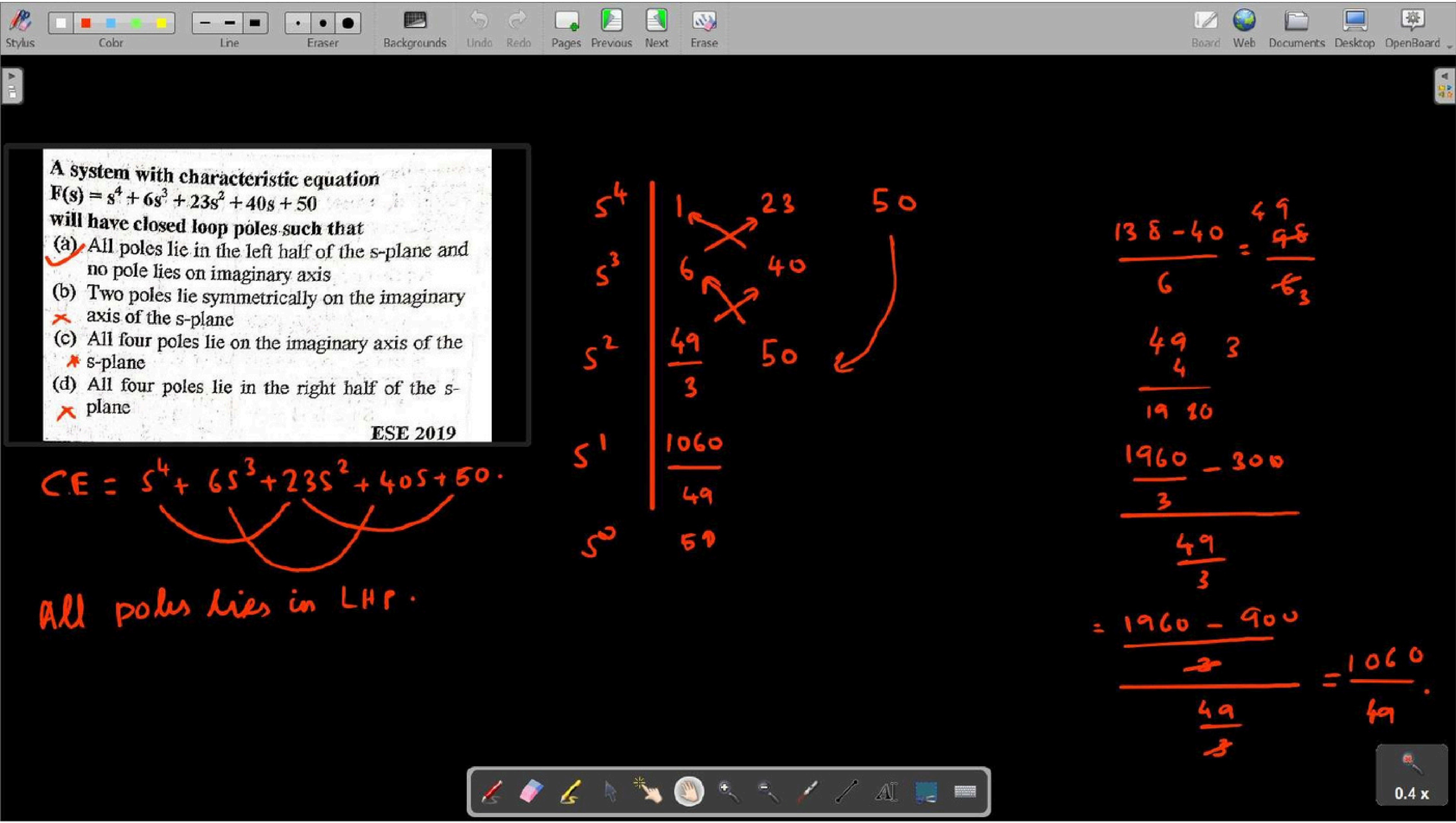

A system with characteristic equation
$F(s) = s^4 + 6s^3 + 23s^2 + 40s + 50$
will have closed loop poles such that

(a) All poles lie in the left half of the s-plane and no pole lies on imaginary axis ✓

(b) Two poles lie symmetrically on the imaginary axis of the s-plane ✗

(c) All four poles lie on the imaginary axis of the s-plane ✗

(d) All four poles lie in the right half of the s-plane ✗

ESE 2019

$CE = s^4 + 6s^3 + 23s^2 + 40s + 50.$

All poles lies in LHP.

s^4	1	23	50
s^3	6	40	
s^2	$\frac{49}{3}$	50	
s^1	$\frac{1060}{49}$		
s^0	50		

$$\frac{138-40}{6} = \frac{\overset{49}{\cancel{98}}}{\cancel{6}_3}$$

$$\begin{array}{cc} 49 & 3 \\ 4 & \\ \hline 19\,80 & \end{array}$$

$$\frac{\frac{1960}{3} - 300}{\frac{49}{3}}$$

$$= \frac{\frac{1960 - 900}{\cancel{3}}}{\frac{49}{\cancel{3}}} = \frac{1060}{49}.$$

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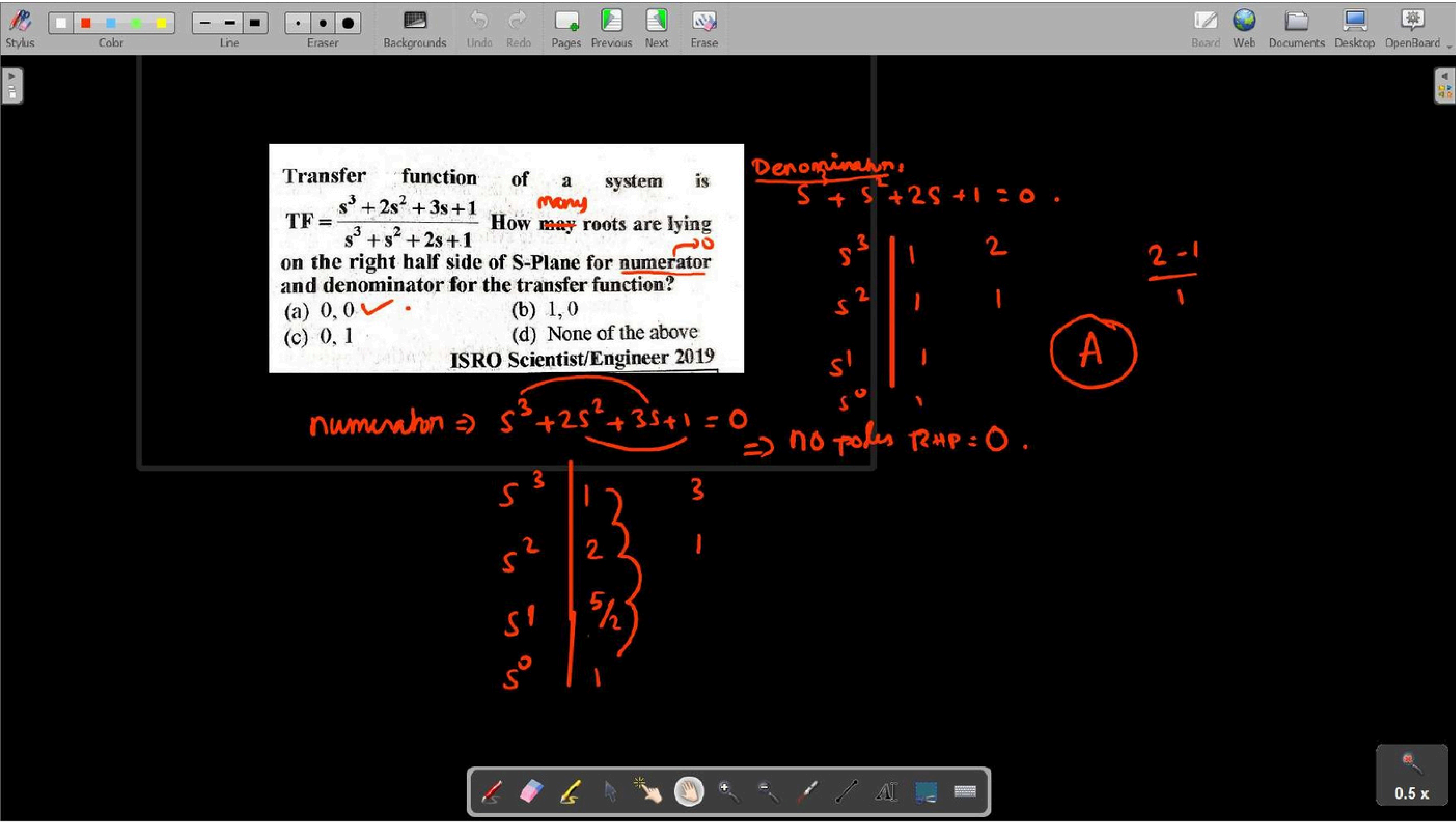

Transfer function of a system is $TF = \frac{s^3 + 2s^2 + 3s + 1}{s^3 + s^2 + 2s + 1}$ How ~~may~~ many roots are lying on the right half side of S-Plane for numerator →0 and denominator for the transfer function?

(a) 0, 0 ✓ (b) 1, 0

(c) 0, 1 (d) None of the above

ISRO Scientist/Engineer 2019

Denominator: $s^3 + s^2 + 2s + 1 = 0$.

$$\begin{array}{c|cc} s^3 & 1 & 2 \\ s^2 & 1 & 1 \\ s^1 & 1 & \\ s^0 & 1 & \end{array}$$

$\frac{2-1}{1}$

$\boxed{A}$

numerator ⇒ $s^3 + 2s^2 + 3s + 1 = 0$

⇒ no poles RHP = 0.

$$\begin{array}{c|cc} s^3 & 1 & 3 \\ s^2 & 2 & 1 \\ s^1 & 5/2 & \\ s^0 & 1 & \end{array}$$

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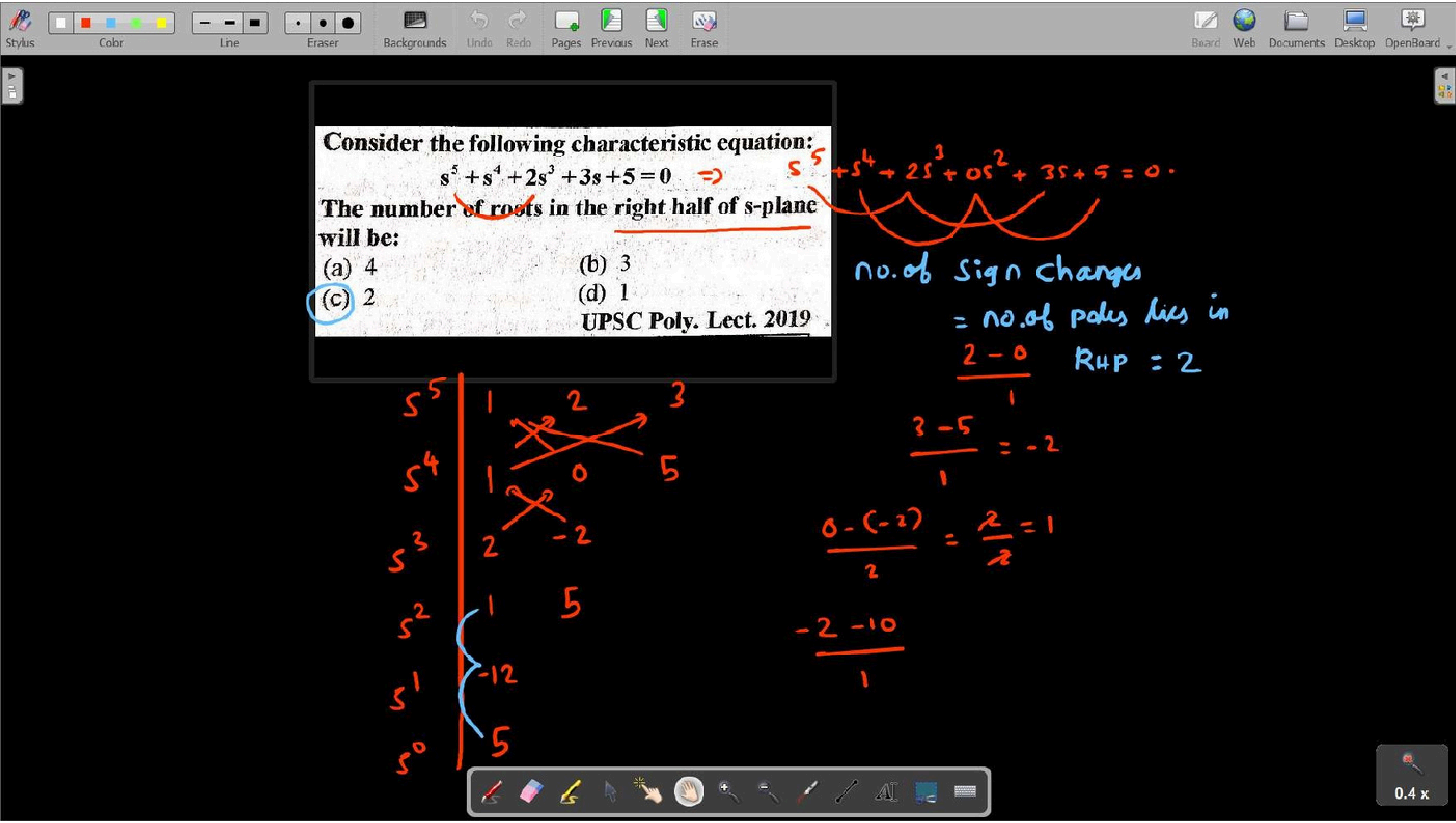


Consider the following characteristic equation:

$$s^5 + s^4 + 2s^3 + 3s + 5 = 0 \Rightarrow s^5 + s^4 + 2s^3 + 0s^2 + 3s + 5 = 0.$$

The number of roots in the right half of s-plane will be:

(a) 4 (b) 3

[✓ (c) 2] (d) 1

UPSC Poly. Lect. 2019

s^5	1	2	3
s^4	1	0	5
s^3	2	-2	
s^2	1	5	
s^1	-12		
s^0	5		

no. of sign changes

= no. of poles lies in RHP = 2

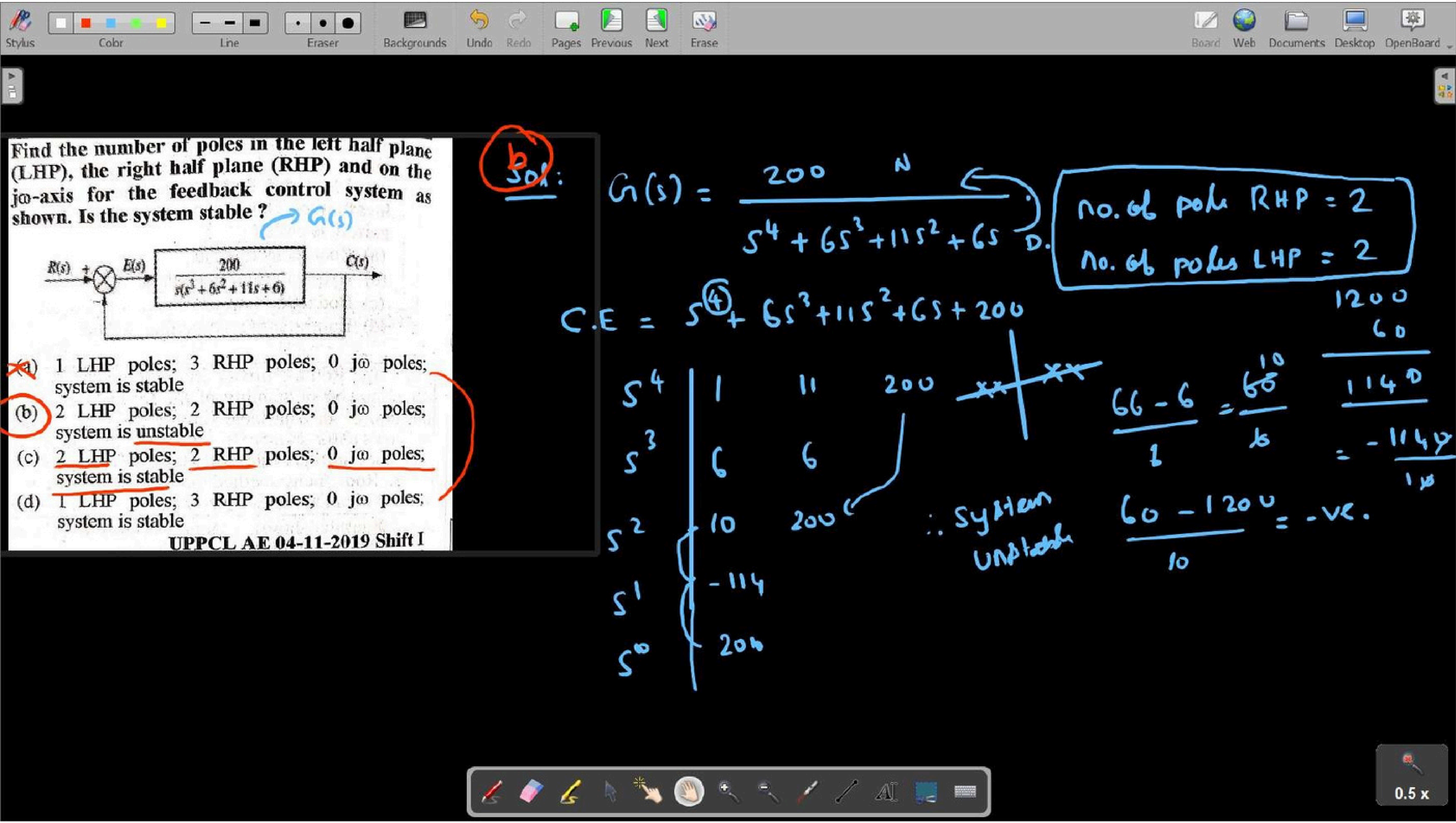
$\frac{2-0}{1}$

$\frac{3-5}{1} = -2$

$\frac{0-(-2)}{2} = \frac{\cancel{2}}{\cancel{2}} = 1$

$\frac{-2-10}{1}$

Full Video Link



Find the number of poles in the left half plane (LHP), the right half plane (RHP) and on the jω-axis for the feedback control system as shown. Is the system stable ? → G(s)

(a) 1 LHP poles; 3 RHP poles; 0 jω poles; system is stable

[✓ (b)] 2 LHP poles; 2 RHP poles; 0 jω poles; system is unstable

(c) 2 LHP poles; 2 RHP poles; 0 jω poles; system is stable

(d) 1 LHP poles; 3 RHP poles; 0 jω poles; system is stable

UPPCL AE 04-11-2019 Shift I

$\boxed{b}$ Sol:

$$G(s) = \frac{200 \quad N}{s^4+6s^3+11s^2+6s \quad D.}$$

$$\boxed{\begin{array}{l}\text{no. of pole RHP} = 2\\ \text{no. of poles LHP} = 2\end{array}}$$

$$C.E = s^{④}+6s^3+11s^2+6s+200$$

$$\begin{array}{c|ccc} s^4 & 1 & 11 & 200 \\ s^3 & 6 & 6 & \\ s^2 & 10 & 200 & \\ s^1 & -114 & & \\ s^0 & 200 & & \end{array}$$

$$\frac{66-6}{1} = \frac{\overset{10}{\cancel{60}}}{\cancel{6}}$$

$$\frac{60-1200}{10} = -ve.$$

1200
60
1140

$$= \frac{-114\cancel{0}}{1\cancel{0}}$$

∴ System unstable

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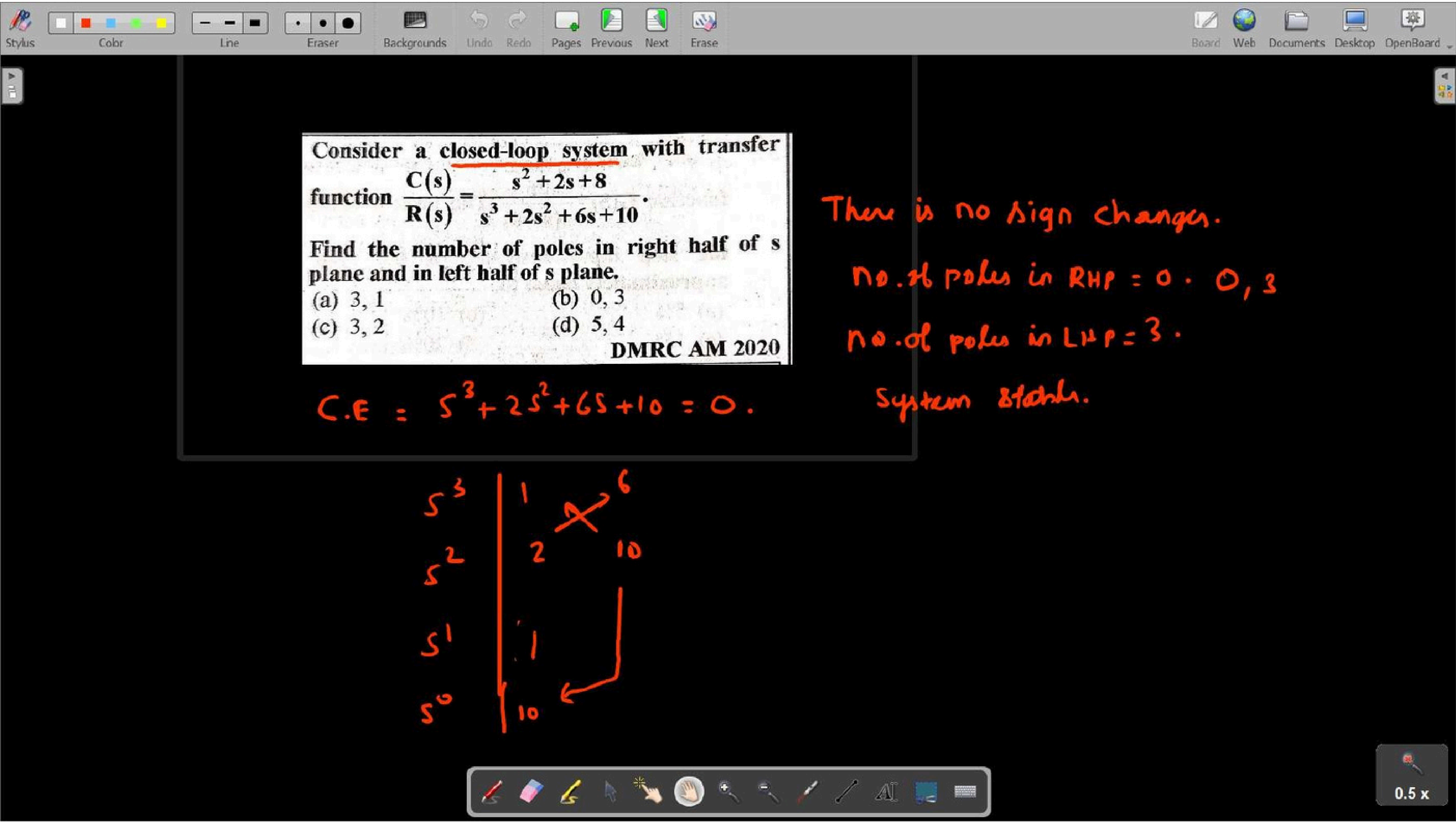


Consider a closed-loop system with transfer function $\frac{C(s)}{R(s)} = \frac{s^2+2s+8}{s^3+2s^2+6s+10}$.

Find the number of poles in right half of s plane and in left half of s plane.

(a) 3, 1
(b) 0, 3
(c) 3, 2
(d) 5, 4

DMRC AM 2020

C.E $= s^3+2s^2+6s+10 = 0.$

$$\begin{array}{c|cc} s^3 & 1 & 6 \\ s^2 & 2 & 10 \\ s^1 & 1 & \\ s^0 & 10 & \end{array}$$

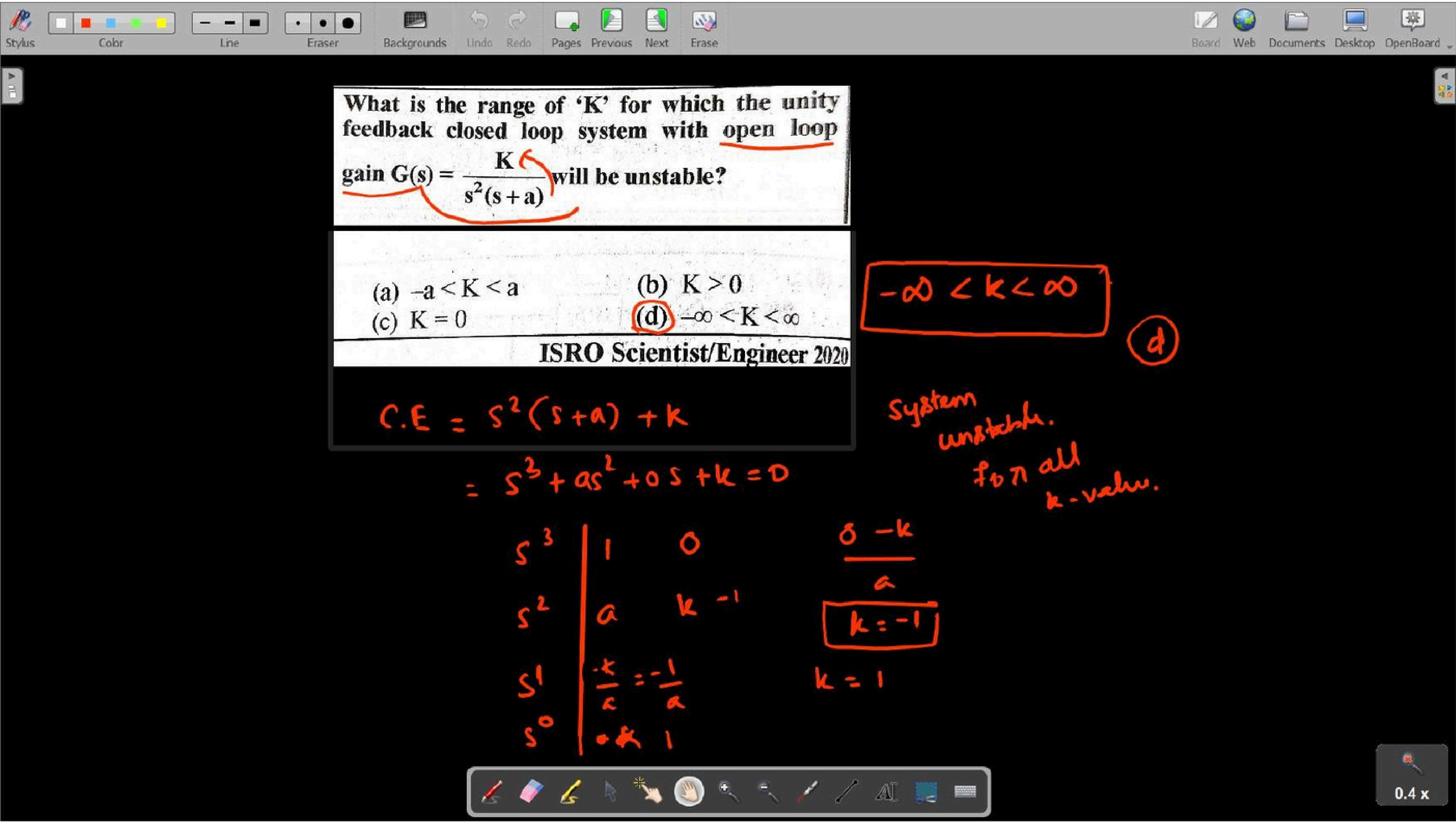
There is no sign changes.

no. of poles in RHP = 0. 0, 3

no. of poles in LHP = 3.

System stable.

Full Video Link



What is the range of 'K' for which the unity feedback closed loop system with open loop gain $G(s) = \frac{K}{s^2(s+a)}$ will be unstable?

(a) $-a < K < a$
(b) $K > 0$
(c) $K = 0$
(d) $-\infty < K < \infty$

ISRO Scientist/Engineer 2020

$$\boxed{-\infty < k < \infty}$$

(d)

$$C.E = s^2(s+a) + k$$

$$= s^3 + as^2 + 0s + k = 0$$

System unstable for all k-value.

$$\begin{array}{c|cc} s^3 & 1 & 0 \\ s^2 & a & k \quad -1 \\ s^1 & \frac{-k}{a} = \frac{-1}{a} & \\ s^0 & k & 1 \end{array}$$

$$\frac{0 - k}{a}$$

$$\boxed{k = -1}$$

$$k = 1$$

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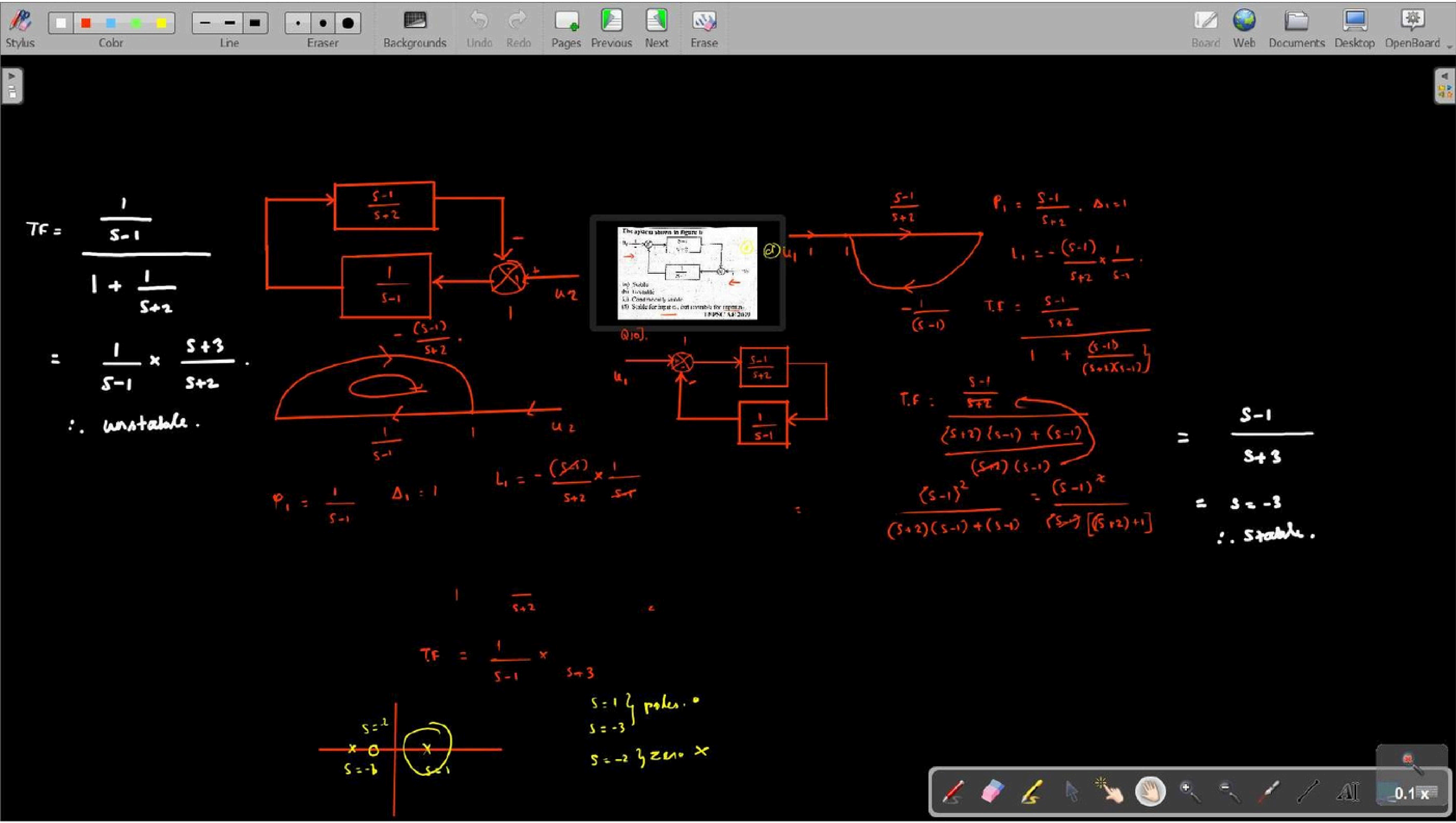

The system shown in figure is

(a) Stable

(b) Unstable

(c) Conditionally stable

(d) Stable for input u1, but unstable for input u2

UPSC ... 2020

Q10].

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

$$= \frac{1}{s-1} \times \frac{s+3}{s+2}.$$

∴ unstable.

$$-\frac{(s-1)}{s+2}.$$

$$\frac{1}{s-1}$$

$$P_1 = \frac{1}{s-1} \qquad \Delta_1 = 1$$

$$L_1 = -\frac{(s-1)}{s+2} \times \frac{1}{s-1}$$

$$P_1 = \frac{s-1}{s+2}. \quad \Delta_1 = 1$$

$$L_1 = -\frac{(s-1)}{s+2} \times \frac{1}{s-1}.$$

$$-\frac{1}{(s-1)}$$

$$T.F = \frac{\frac{s-1}{s+2}}{1 + \frac{(s-1)}{(s+2)(s-1)}}$$

$$T.F: \frac{\frac{s-1}{s+2}}{\frac{(s+2)(s-1)+(s-1)}{(s+2)(s-1)}}$$

$$\frac{(s-1)^2}{(s+2)(s-1)+(s-1)} = \frac{(s-1)^2}{(s-1)[(s+2)+1]}$$

$$= \frac{s-1}{s+3}$$

$$= s = -3$$

∴ stable.

$$TF = \frac{1}{s-1} \times s+3$$

s = 1 } poles.

s = -3

s = -2 } zero ×

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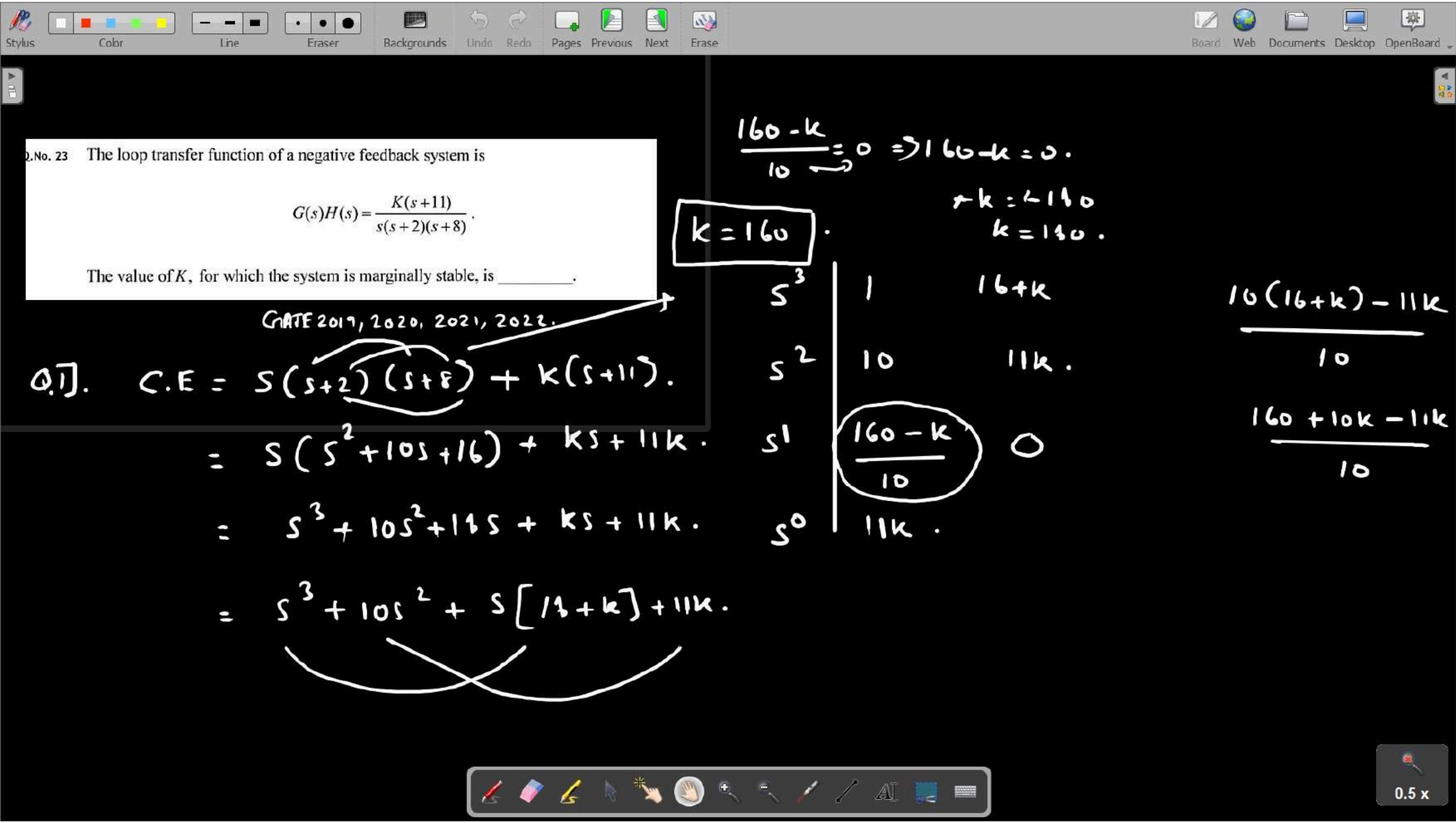

.No. 23 The loop transfer function of a negative feedback system is

$$G(s)H(s)=\frac{K(s+11)}{s(s+2)(s+8)}.$$

The value of K, for which the system is marginally stable, is ________.

GATE 2019, 2020, 2021, 2022.

Q.1]. $C.E = s(s+2)(s+8) + k(s+11).$

$= s(s^2+10s+16) + ks + 11k.$

$= s^3 + 10s^2 + 16s + ks + 11k.$

$= s^3 + 10s^2 + s[16+k] + 11k.$

$\frac{160-k}{10} = 0 \Rightarrow 160-k = 0.$

$-k = -160$

$k = 160.$

$\boxed{k = 160}.$

s^3	1	$16+k$
s^2	10	$11k.$
s^1	$\frac{160-k}{10}$	0
s^0	$11k.$	

$\frac{10(16+k) - 11k}{10}$

$\frac{160 + 10k - 11k}{10}$

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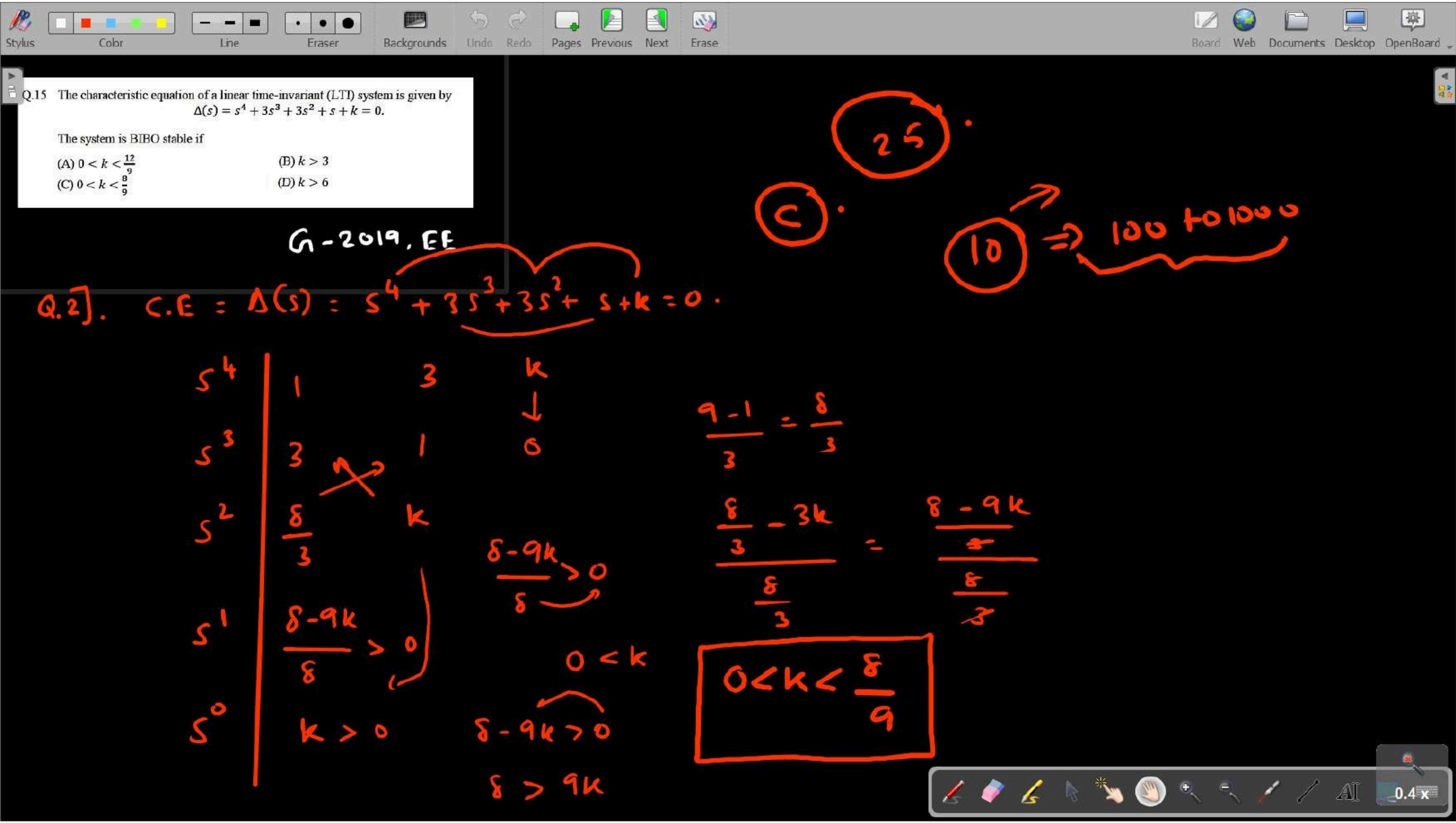

Q.15 The characteristic equation of a linear time-invariant (LTI) system is given by

$$\Delta(s) = s^4 + 3s^3 + 3s^2 + s + k = 0.$$

The system is BIBO stable if

(A) $0 < k < \frac{12}{9}$ (B) $k > 3$

(C) $0 < k < \frac{8}{9}$ (D) $k > 6$

G-2019, EE

25 .

C .

10 ⇒ 100 to 1000

Q.2]. C.E = $\Delta(s) = s^4 + 3s^3 + 3s^2 + s + k = 0$.

$$\begin{array}{c|ccc} s^4 & 1 & 3 & k \\ s^3 & 3 & 1 & 0 \\ s^2 & \frac{8}{3} & k & \\ s^1 & \frac{8-9k}{8} > 0 & & \\ s^0 & k > 0 & & \end{array}$$

$$\frac{9-1}{3} = \frac{8}{3}$$

$$\frac{\frac{8}{3} - 3k}{\frac{8}{3}} = \frac{\frac{8-9k}{\cancel{3}}}{\frac{8}{\cancel{3}}}$$

$$\frac{8-9k}{8} > 0$$

$0 < k$

$8 - 9k > 0$

$8 > 9k$

$$\boxed{0 < k < \frac{8}{9}}$$

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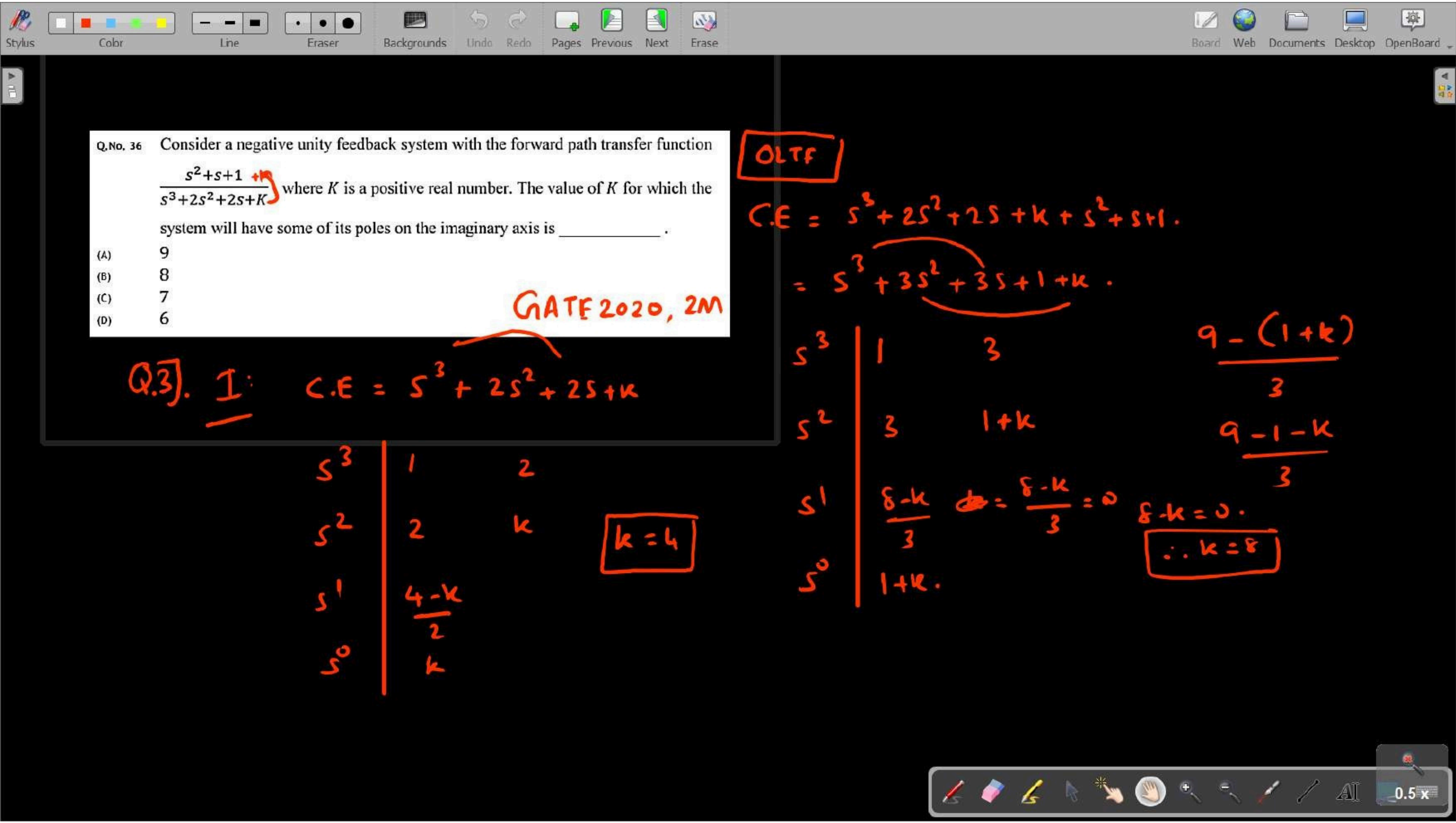

Q.No. 36 Consider a negative unity feedback system with the forward path transfer function $\frac{s^2+s+1 \; +k}{s^3+2s^2+2s+K}$ where K is a positive real number. The value of K for which the system will have some of its poles on the imaginary axis is ____________ .

(A) 9

(B) 8

(C) 7

(D) 6

GATE 2020, 2M

OLTF

$$C.E = s^3+2s^2+2s+k+s^2+s+1.$$

$$= s^3+3s^2+3s+1+k.$$

$$\begin{array}{c|cc} s^3 & 1 & 3 \\ s^2 & 3 & 1+k \\ s^1 & \frac{8-k}{3} & \\ s^0 & 1+k. & \end{array}$$

$$\frac{9-(1+k)}{3}$$

$$\frac{9-1-k}{3}$$

$$= \frac{8-k}{3} = 0$$

$$8-k = 0.$$

$$\boxed{\therefore k = 8}$$

Q.3). I:

$$C.E = s^3+2s^2+2s+k$$

$$\begin{array}{c|cc} s^3 & 1 & 2 \\ s^2 & 2 & k \\ s^1 & \frac{4-k}{2} & \\ s^0 & k & \end{array}$$

$$\boxed{k = 4}$$

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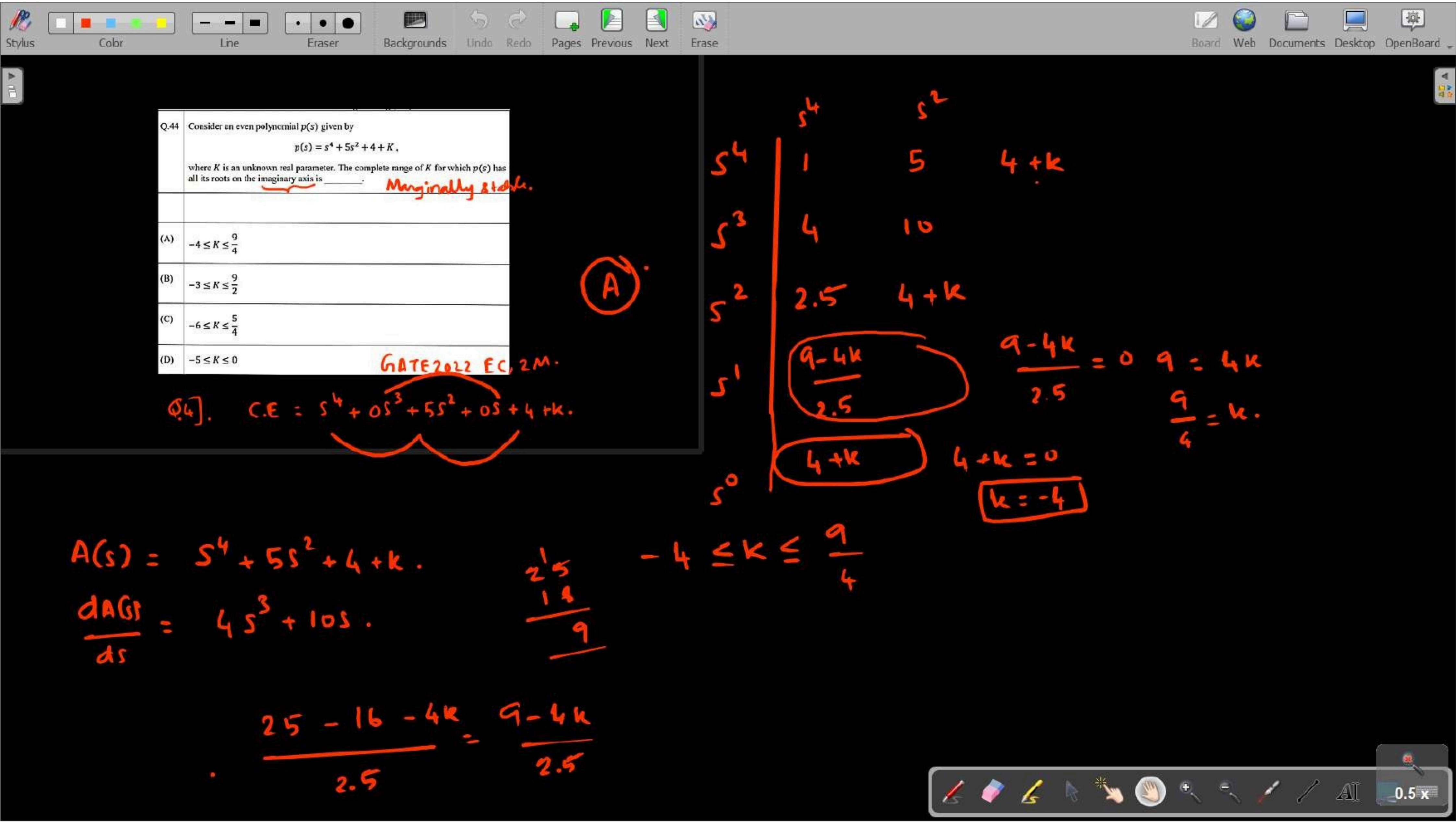


Q.44 Consider an even polynomial $p(s)$ given by

$$p(s) = s^4 + 5s^2 + 4 + K,$$

where K is an unknown real parameter. The complete range of K for which $p(s)$ has all its roots on the imaginary axis is ______.

Marginally stable.

(A)	$-4 \le K \le \frac{9}{4}$
(B)	$-3 \le K \le \frac{9}{2}$
(C)	$-6 \le K \le \frac{5}{4}$
(D)	$-5 \le K \le 0$

GATE 2022 EC, 2M.

$\textcircled{A}$.

Q4]. $C.E : s^4 + 0s^3 + 5s^2 + 0s + 4 + k.$

	s^4	s^2	
s^4	1	5	$4+k$
s^3	4	10	
s^2	2.5	$4+k$	
s^1	$\frac{9-4k}{2.5}$		
s^0	$4+k$		

$\frac{9-4k}{2.5} = 0 \quad 9 = 4k$

$\frac{9}{4} = k.$

$4+k=0$

$\boxed{k=-4}$

$-4 \le k \le \frac{9}{4}$

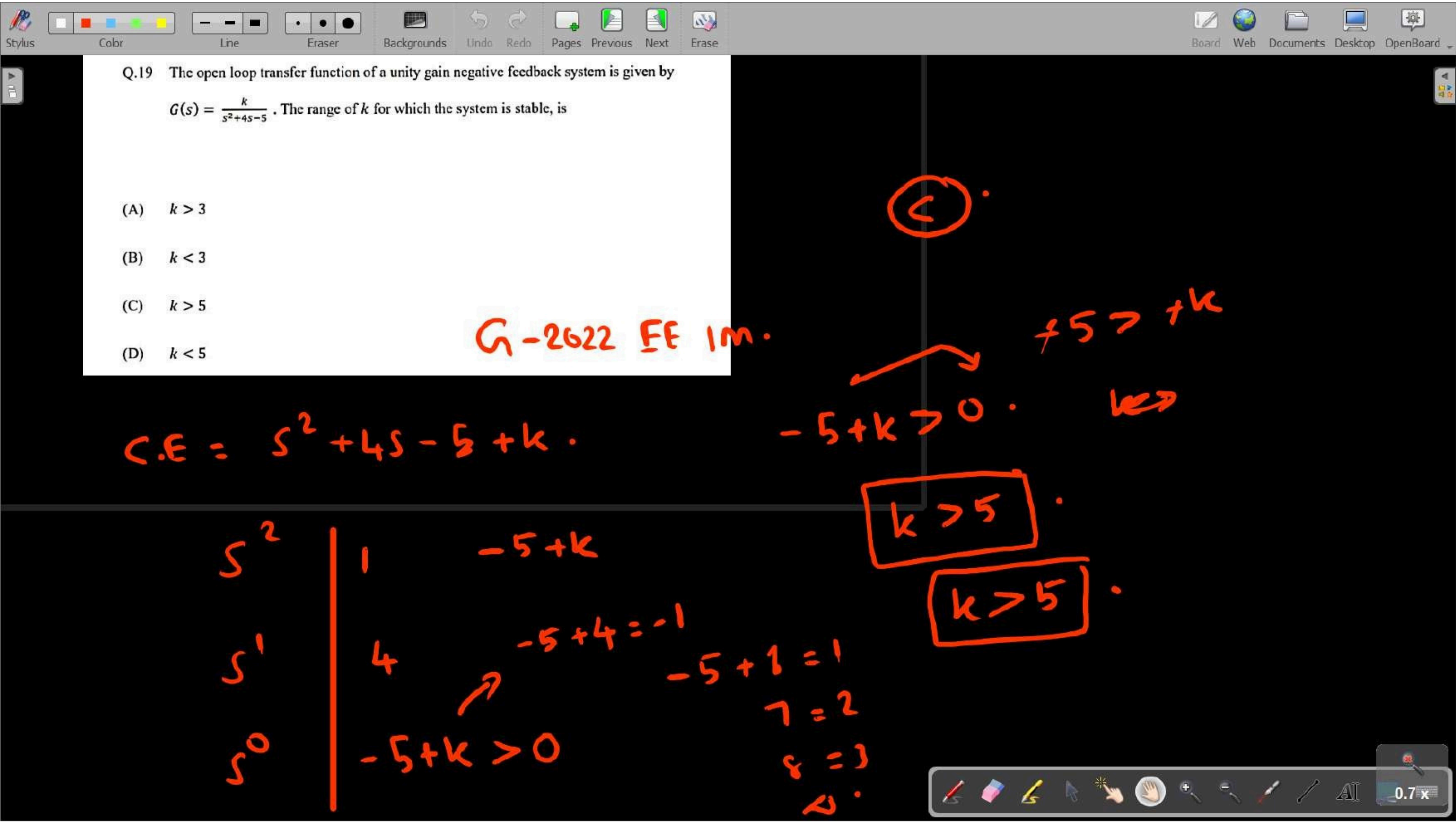
$A(s) = s^4 + 5s^2 + 4 + k.$

$\frac{dA(s)}{ds} = 4s^3 + 10s.$

$\begin{array}{r} 2\overset{1}{5} \\ 16 \\ \hline 9 \\ \hline \end{array}$

$\frac{25 - 16 - 4k}{2.5} = \frac{9-4k}{2.5}$

Full Video Link



Q.19 The open loop transfer function of a unity gain negative feedback system is given by $G(s) = \frac{k}{s^2+4s-5}$. The range of k for which the system is stable, is

(A) $k > 3$

(B) $k < 3$

(C) $k > 5$

(D) $k < 5$

G-2022 EE 1M.

(C).

$C.E = s^2 + 4s - 5 + k.$

s^2	1	$-5+k$
s^1	4	
s^0	$-5+k > 0$	

$-5+4=-1$

$-5+1=1$

$7=2$

$8=3$

$-5+k > 0.$

$+5 > +k$

$k>$

$\boxed{k > 5}.$

$\boxed{k > 5}.$

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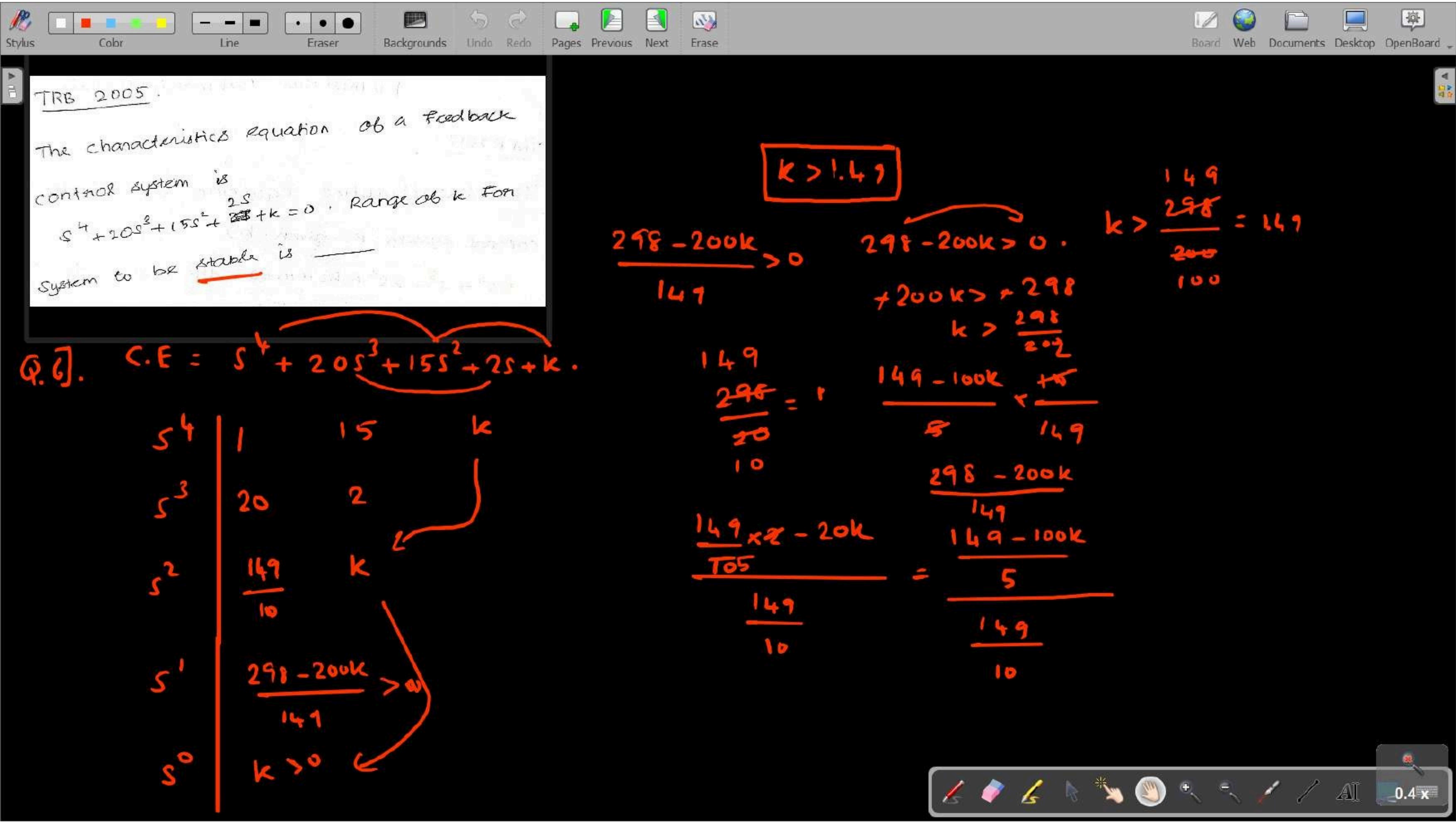


TRB 2005.

The characteristics equation of a feedback control system is $s^4 + 20s^3 + 15s^2 + \overset{2s}{\cancel{23}} + k = 0$. Range of k for system to be stable is ______

Q. 6]. $C.E = s^4 + 20s^3 + 15s^2 + 2s + k.$

s^4	1	15	k
s^3	20	2	
s^2	$\frac{149}{10}$	k	
s^1	$\frac{298-200k}{149} > 0$		
s^0	$k > 0$		

$$\boxed{k > 1.49}$$

$$\frac{298-200k}{149} > 0$$

$$298 - 200k > 0.$$

$$\cancel{+}200k > \cancel{+}298$$

$$k > \frac{298}{\cancel{200}}$$

$$k > \frac{\overset{149}{\cancel{298}}}{\underset{100}{\cancel{200}}} = 1.49$$

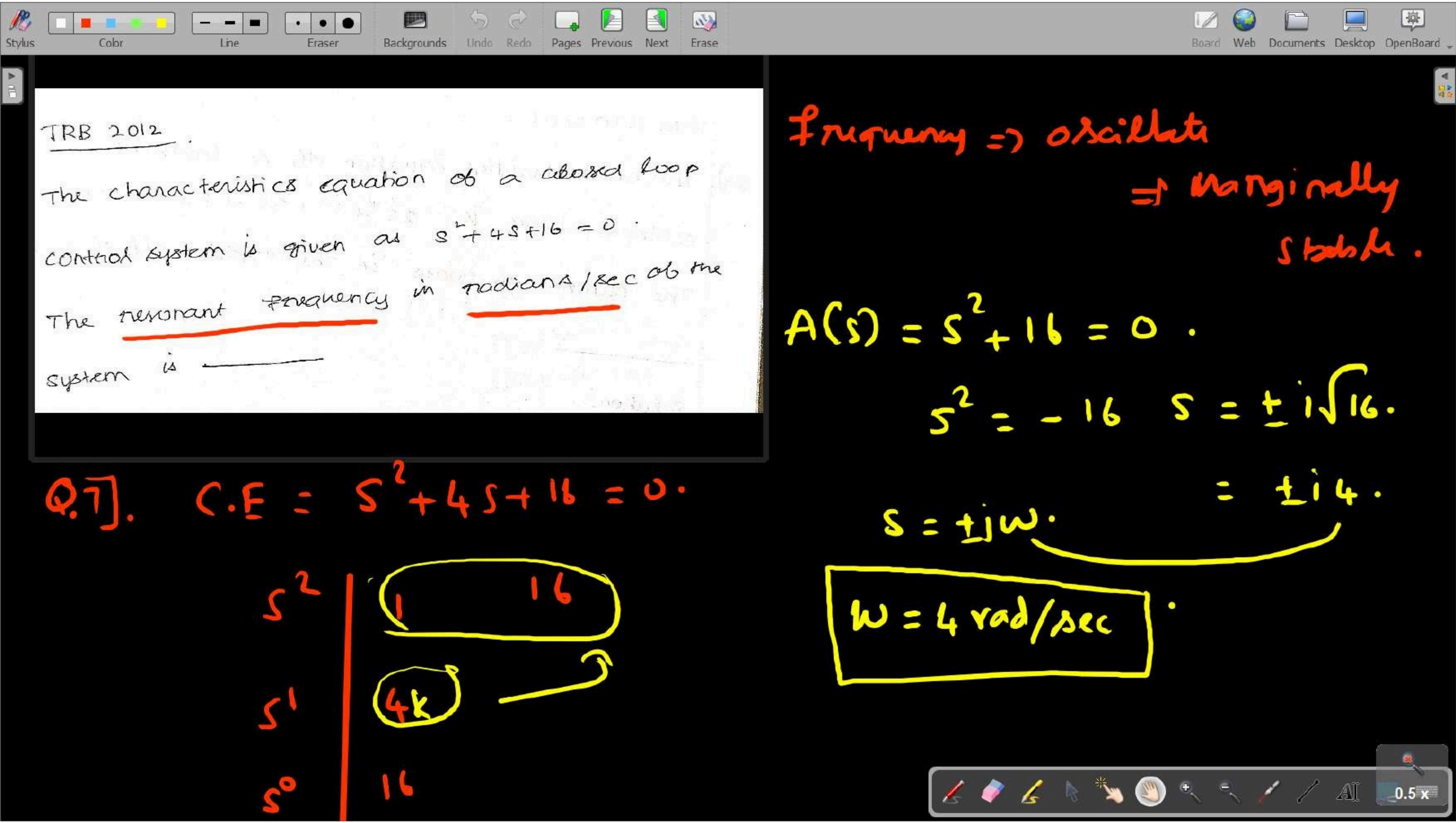
$$\frac{\overset{149}{\cancel{298}}}{\underset{10}{\cancel{20}}} = 1$$

$$\frac{149-100k}{\cancel{5}} \times \frac{\cancel{10}}{149}$$

$$\frac{298-200k}{149}$$

$$\frac{\frac{149}{\cancel{10}5} \times \cancel{2} - 20k}{\frac{149}{10}} = \frac{\frac{149-100k}{5}}{\frac{149}{10}}$$

Full Video Link



TRB 2012.

The characteristics equation of a closed loop control system is given as $s^2+4s+16=0$. The resonant frequency in radians/sec of the system is ____

Q.7]. $C.E = s^2+4s+16=0$.

s^2	1	16
s^1	4k	
s^0	16	

frequency => oscillati

=> marginally stable.

$A(s) = s^2+16 = 0$.

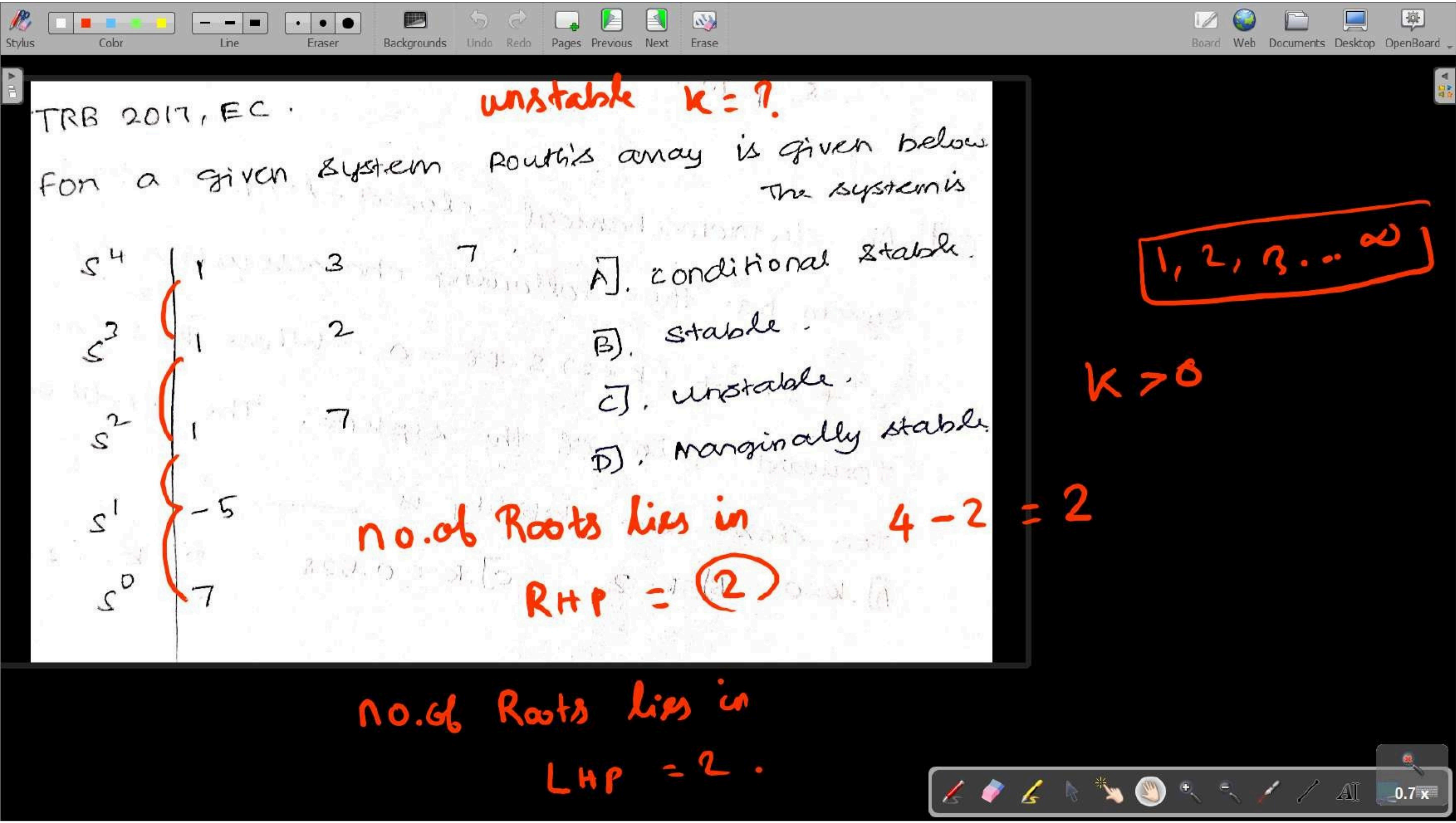
$s^2 = -16$ $s = \pm i\sqrt{16}$.

$= \pm i4$.

$s = \pm jw$.

$\boxed{w = 4 \text{ rad/sec}}$.

Full Video Link



TRB 2017, EC.

unstable K = ?.

For a given system Routh's array is given below. The system is

s^4	1	3	7
s^3	1	2	
s^2	1	7	
s^1	-5		
s^0	7		

A]. conditional stable.

B). stable.

C]. unstable.

D). marginally stable.

$\boxed{1, 2, 3 \ldots \infty}$

$K > 0$

no.of Roots lies in RHP = ②

$4 - 2 = 2$

no.of Roots lies in LHP = 2.

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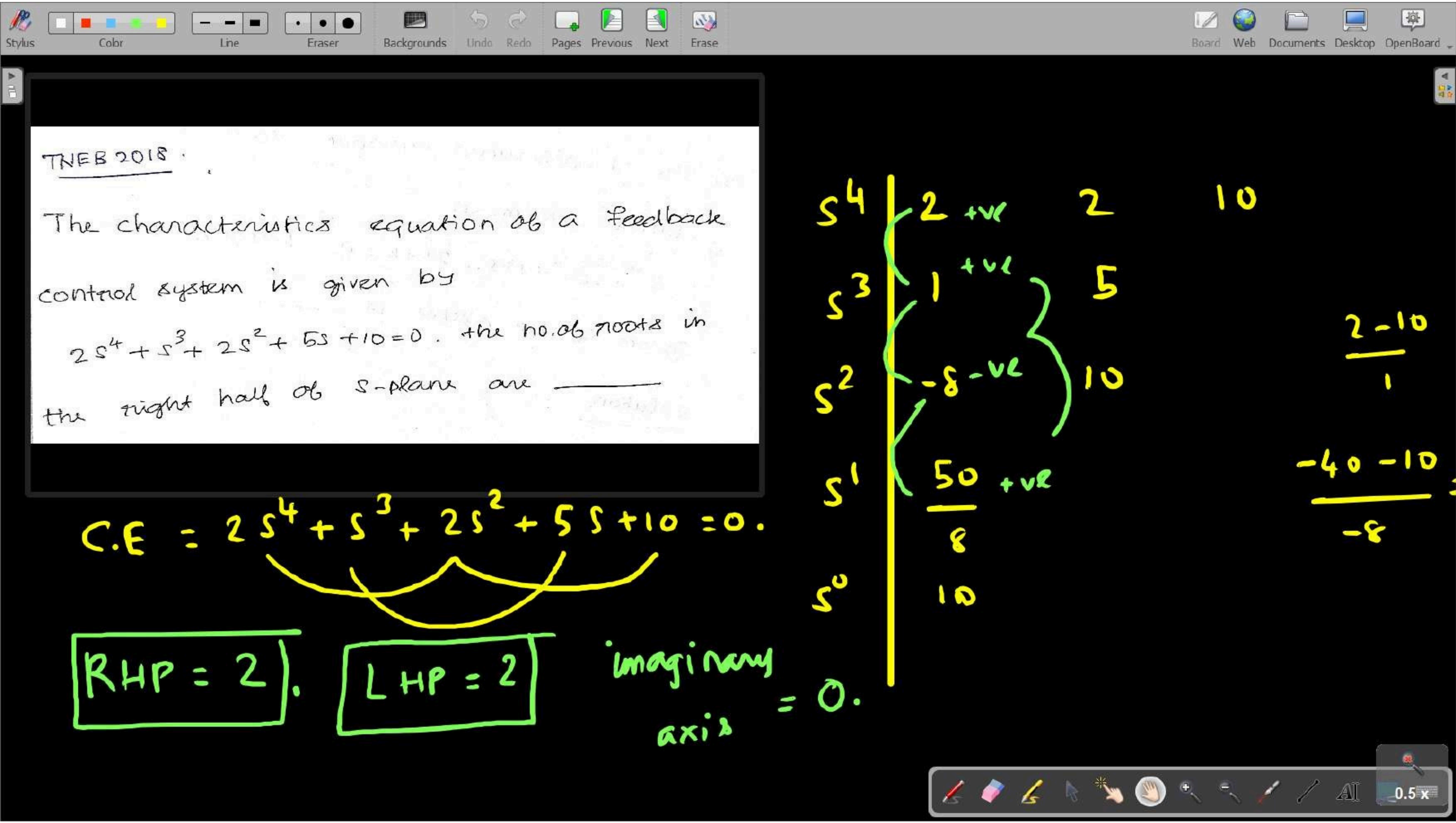

TNEB 2018 .

The characteristics equation of a feedback control system is given by $2s^4+s^3+2s^2+5s+10=0$. the no. of roots in the right half of s-plane are ______

$$C.E = 2s^4+s^3+2s^2+5s+10=0.$$

s^4	2 +ve	2	10
s^3	1 +ve	5	
s^2	-8 -ve	10	
s^1	$\frac{50}{8}$ +ve		
s^0	10		

$$\frac{2-10}{1}$$

$$\frac{-40-10}{-8}$$

$\boxed{RHP = 2}$. $\boxed{LHP = 2}$ imaginary axis = 0.

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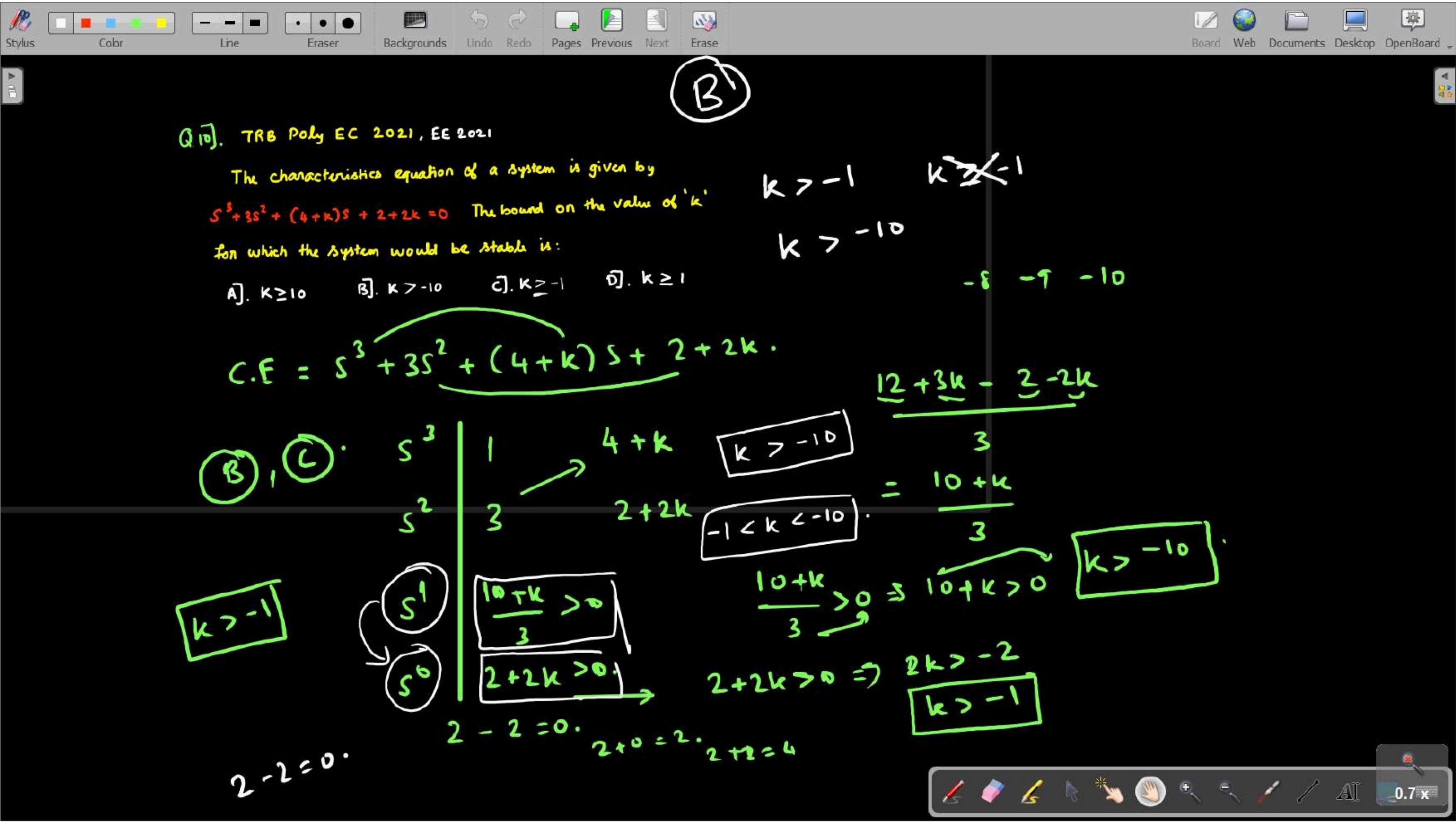

Ⓑ

Q 10]. TRB Poly EC 2021, EE 2021

The characteristics equation of a system is given by $s^3+3s^2+(4+k)s+2+2k=0$ The bound on the value of 'k' for which the system would be stable is:

A]. $k \geq 10$ B]. $k > -10$ C]. $k \geq -1$ D]. $k \geq 1$

$k > -1$ $k \cancel{>} < -1$

$k > -10$

-8 -9 -10

$$C.F = s^3 + 3s^2 + (4+k)s + 2 + 2k.$$

$$\frac{12+3k - 2-2k}{3} = \frac{10+k}{3}$$

Ⓑ, Ⓒ.

$$\begin{array}{c|cc} s^3 & 1 & 4+k \\ s^2 & 3 & 2+2k \\ s^1 & \boxed{\frac{10+k}{3} > 0} & \\ s^0 & \boxed{2+2k > 0.} & \end{array}$$

$\boxed{k > -10}$

$\boxed{-1 < k < -10}$.

$\boxed{k > -1}$

$\frac{10+k}{3} > 0 \Rightarrow 10+k > 0$ $\boxed{k > -10}$.

$2+2k > 0 \Rightarrow 2k > -2$

$\boxed{k > -1}$

$2-2=0.$ $2+0=2.$ $2+2=4$

$2-2=0.$

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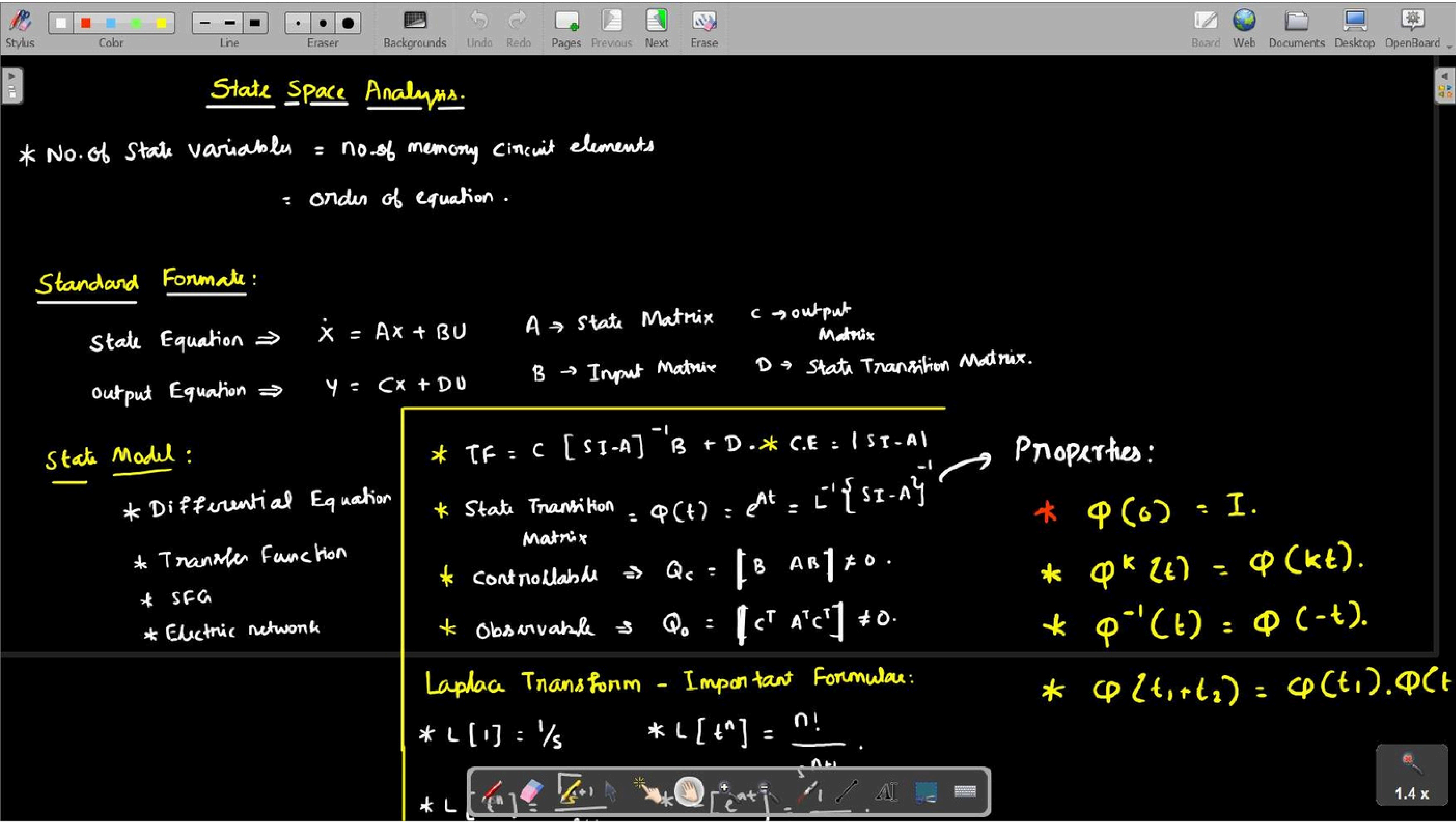

State Space Analysis.

* No. of State variables = no. of memory circuit elements
  = order of equation.

Standard Formate:

State Equation ⇒ $\dot{x} = Ax + BU$

output Equation ⇒ $y = Cx + DU$

A → State Matrix

B → Input Matrix

C → output Matrix

D → State Transition Matrix.

State Model:

- Differential Equation
- Transfer Function
- SFG
- Electric network

* $TF = C[SI-A]^{-1}B + D$. * $C.E = |SI-A|$

* State Transition Matrix $= \phi(t) = e^{At} = L^{-1}\{SI-A\}^{-1}$ → Properties:

* Controllable ⇒ $Q_c = [B \ \ AB] \neq 0$.

* Observable ⇒ $Q_0 = [C^T \ \ A^TC^T] \neq 0$.

Properties:

* $\phi(0) = I$.
* $\phi^k(t) = \phi(kt)$.
* $\phi^{-1}(t) = \phi(-t)$.
* $\phi(t_1+t_2) = \phi(t_1).\phi(t$

Laplace Transform - Important Formulae:

* $L[1] = 1/s$
* $L[t^n] = \frac{n!}{s^{n+1}}$.
* L

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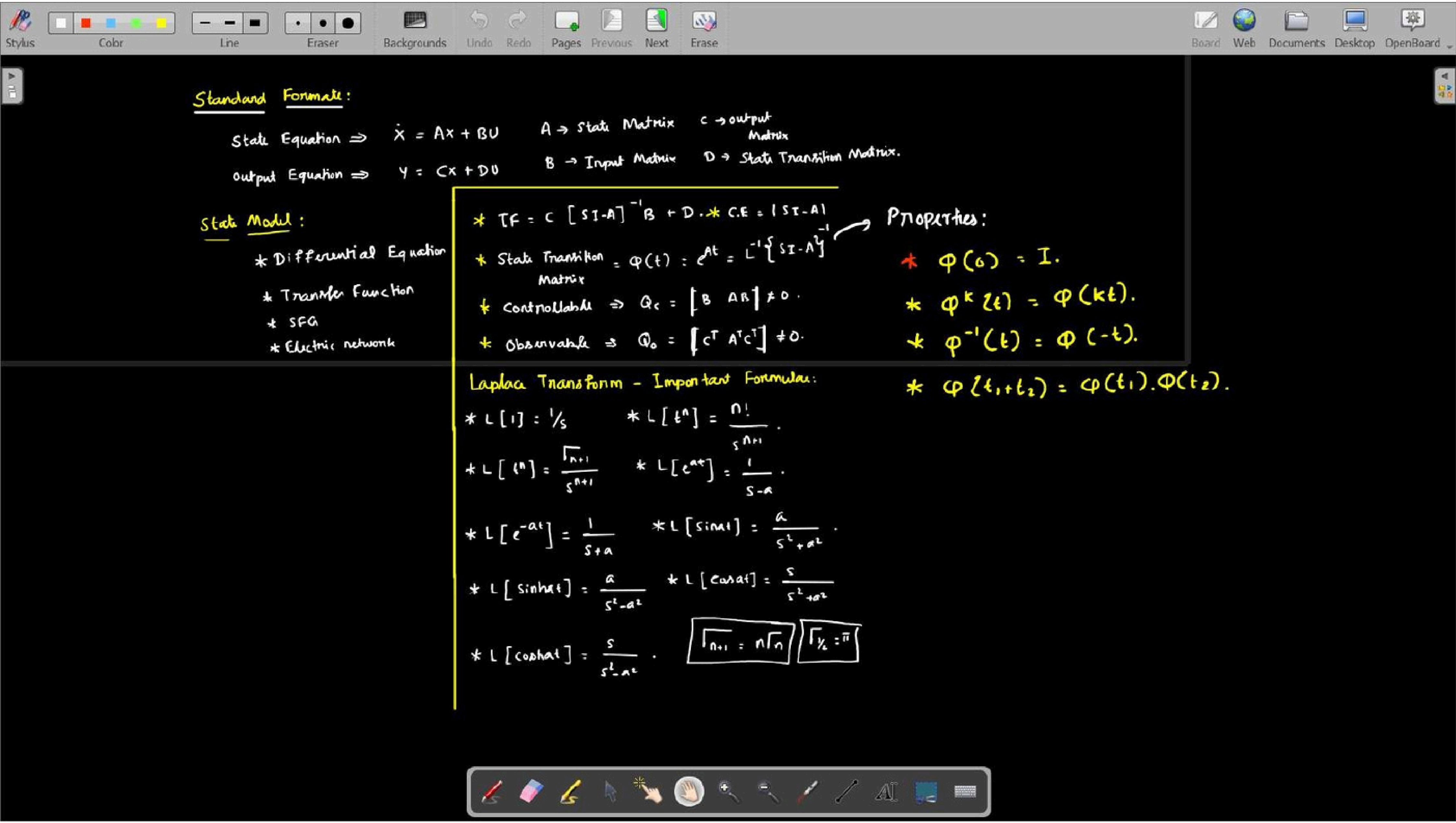

Standard Formate:

State Equation ⇒ $\dot{X} = AX + BU$

Output Equation ⇒ $Y = CX + DU$

A → State Matrix

B → Input Matrix

C → output Matrix

D → State Transition Matrix.

State Model:

- * Differential Equation
- * Transfer Function
- * SFG
- * Electric network

* $TF = C[SI-A]^{-1}B + D$. * C.E $= |SI-A|$

* State Transition Matrix $= \phi(t) = e^{At} = L^{-1}\{SI-A\}^{-1}$

* Controllable ⇒ $Q_c = [B \quad AB] \neq 0$.

* Observable ⇒ $Q_o = [C^T \quad A^TC^T] \neq 0$.

→ Properties:

* $\phi(0) = I$.

* $\phi^k(t) = \phi(kt)$.

* $\phi^{-1}(t) = \phi(-t)$.

* $\phi(t_1+t_2) = \phi(t_1).\phi(t_2)$.

Laplace Transform - Important Formulae:

* $L[1] = 1/s$ * $L[t^n] = \frac{n!}{s^{n+1}}$.

* $L[t^n] = \frac{\Gamma_{n+1}}{s^{n+1}}$ * $L[e^{at}] = \frac{1}{s-a}$.

* $L[e^{-at}] = \frac{1}{s+a}$ * $L[\sin at] = \frac{a}{s^2+a^2}$.

* $L[\sinh at] = \frac{a}{s^2-a^2}$ * $L[\cos at] = \frac{s}{s^2+a^2}$

* $L[\cosh at] = \frac{s}{s^2-a^2}$. $\boxed{\Gamma_{n+1} = n\Gamma_n}$ $\boxed{\Gamma_{1/2} = \pi}$

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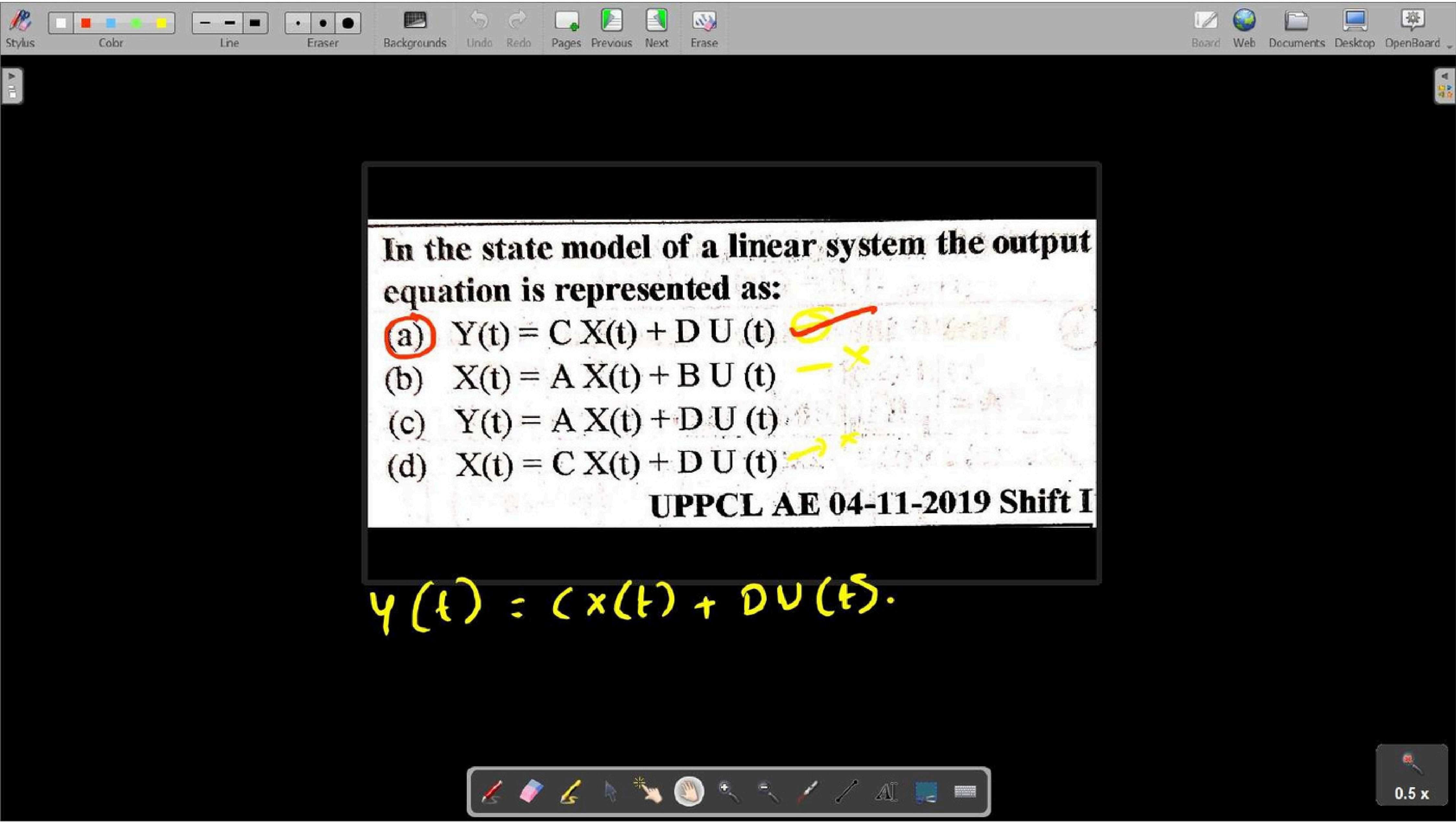

In the state model of a linear system the output equation is represented as:

[✓ (a)] $Y(t) = C\,X(t) + D\,U(t)$ ✓

(b) $X(t) = A\,X(t) + B\,U(t)$ — ✗

(c) $Y(t) = A\,X(t) + D\,U(t)$

(d) $X(t) = C\,X(t) + D\,U(t)$ → ✗

UPPCL AE 04-11-2019 Shift I

$y(t) = C\,x(t) + D\,U(t).$

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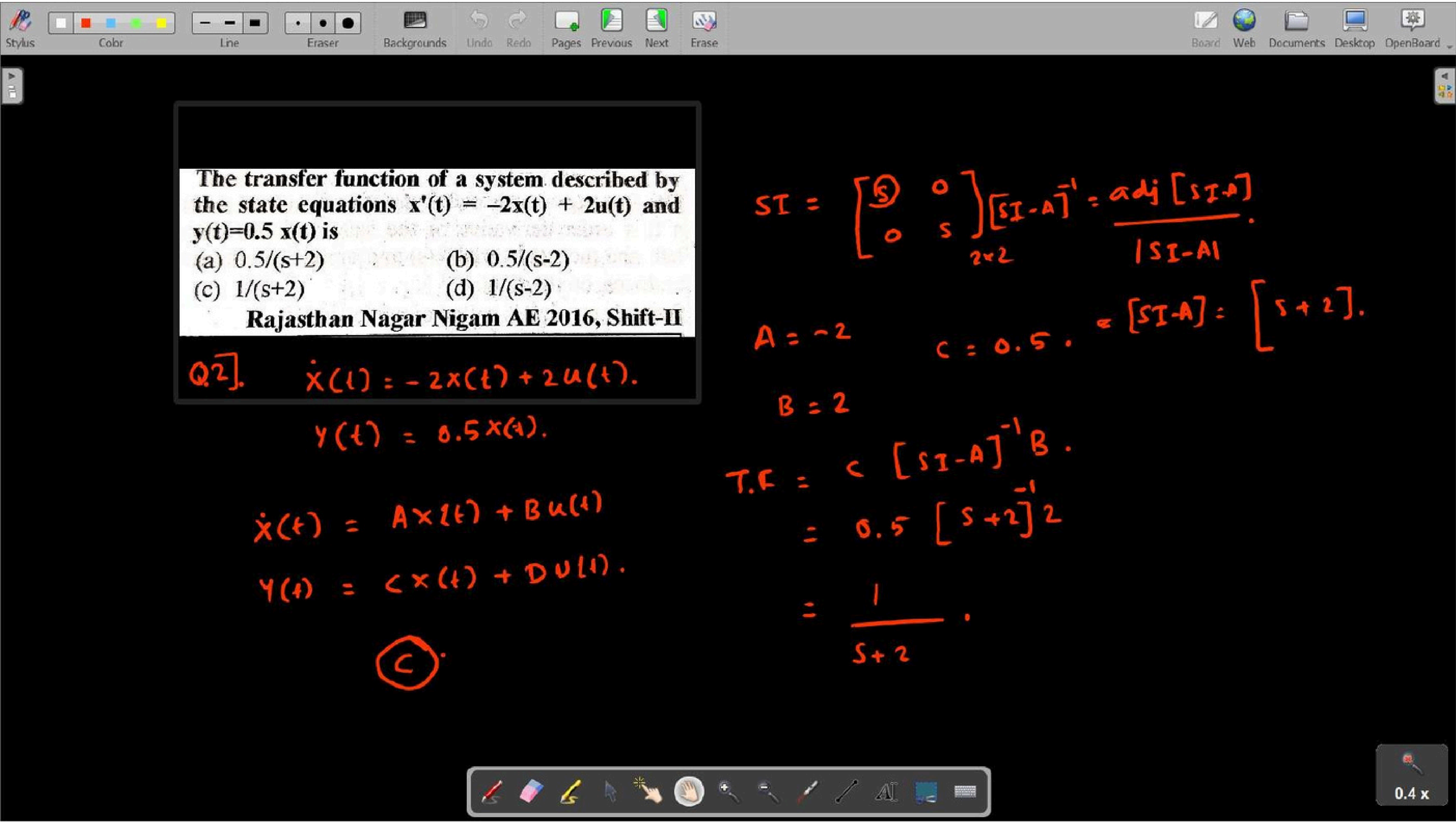

The transfer function of a system described by the state equations x'(t) = –2x(t) + 2u(t) and y(t)=0.5 x(t) is

(a) 0.5/(s+2) (b) 0.5/(s-2)

(c) 1/(s+2) (d) 1/(s-2)

Rajasthan Nagar Nigam AE 2016, Shift-II

Q2]. $\dot{x}(t) = -2x(t) + 2u(t).$

$y(t) = 0.5x(t).$

$\dot{x}(t) = Ax(t) + Bu(t)$

$y(t) = Cx(t) + DU(t).$

ⓒ.

$SI = \begin{bmatrix} \textcircled{s} & 0 \\ 0 & s \end{bmatrix}_{2\times 2}$ $[SI-A]^{-1} = \dfrac{adj[SI-A]}{|SI-A|}.$

$A = -2$ $C = 0.5.$ $\Rightarrow [SI-A] = [s+2].$

$B = 2$

$T.F = C[SI-A]^{-1}B.$

$= 0.5[s+2]^{-1}2$

$= \dfrac{1}{s+2}.$

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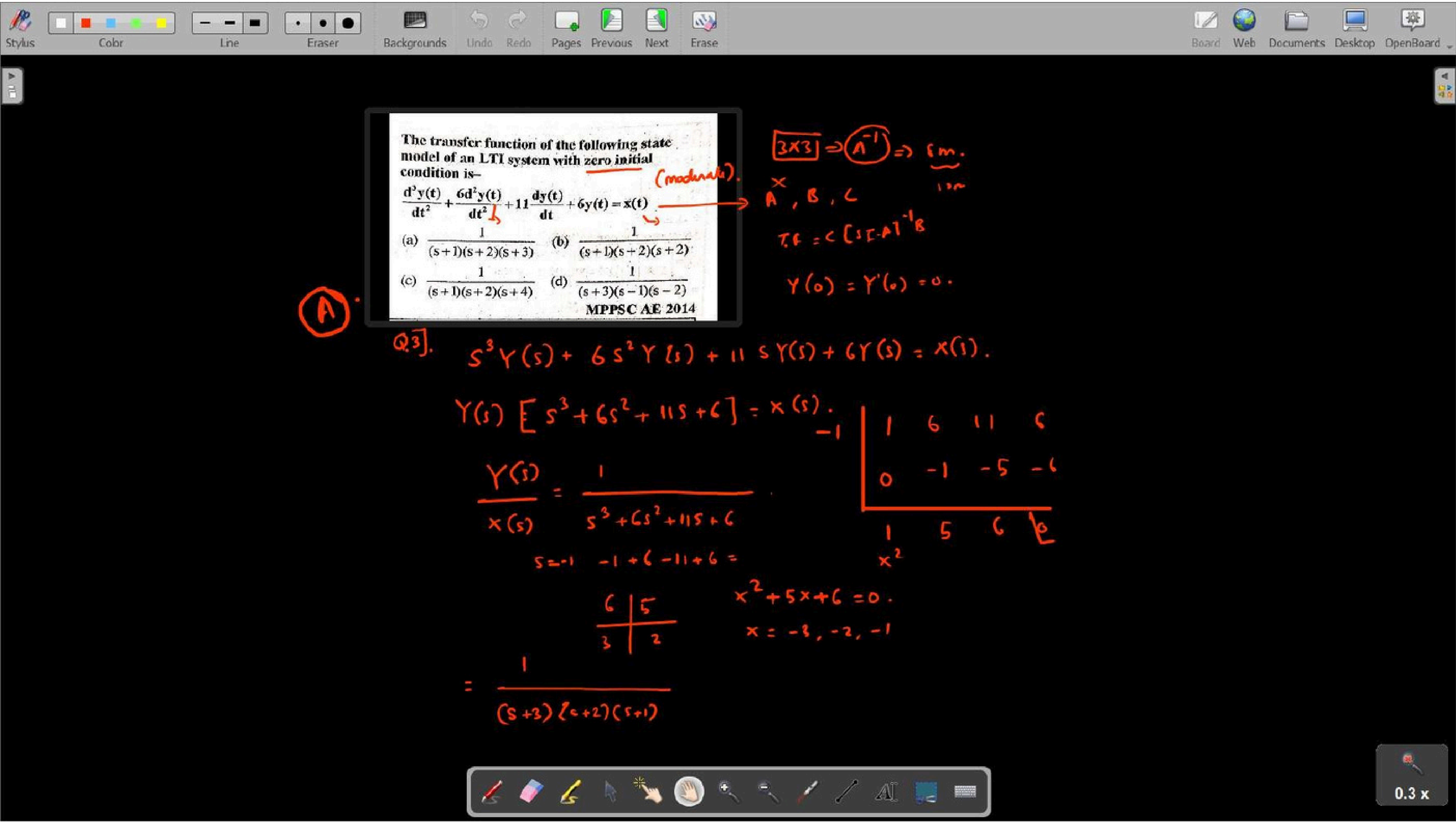

The transfer function of the following state model of an LTI system with zero initial condition is– (modnale).

$$\frac{d^3y(t)}{dt^2} + \frac{6d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 6y(t) = x(t) \longrightarrow \overset{\times}{A}, B, C$$

(a) $\frac{1}{(s+1)(s+2)(s+3)}$ (b) $\frac{1}{(s+1)(s+2)(s+2)}$

(c) $\frac{1}{(s+1)(s+2)(s+4)}$ (d) $\frac{1}{(s+3)(s-1)(s-2)}$

MPPSC AE 2014

Ⓐ.

$\boxed{3\times3} \Rightarrow A^{-1} \Rightarrow \underbrace{\text{Sm.}}_{\text{1m}}$

$T.F = C[sI-A]^{-1}B$

$Y(0) = Y'(0) = 0.$

Q3].

$s^3Y(s) + 6s^2Y(s) + 11sY(s) + 6Y(s) = X(s).$

$Y(s)[s^3+6s^2+11s+6] = X(s).$

$$\frac{Y(s)}{X(s)} = \frac{1}{s^3+6s^2+11s+6}$$

$s=-1 \quad -1+6-11+6 =$

$$\begin{array}{r|rrrr} -1 & 1 & 6 & 11 & 6 \\ & 0 & -1 & -5 & -6 \\ \hline & 1 & 5 & 6 & \boxed{0} \\ & x^2 & & & \end{array}$$

$$\begin{array}{c|c} 6 & 5 \\ \hline 3 & 2 \end{array}$$

$x^2+5x+6=0.$

$x = -3, -2, -1$

$$= \frac{1}{(s+3)(s+2)(s+1)}$$

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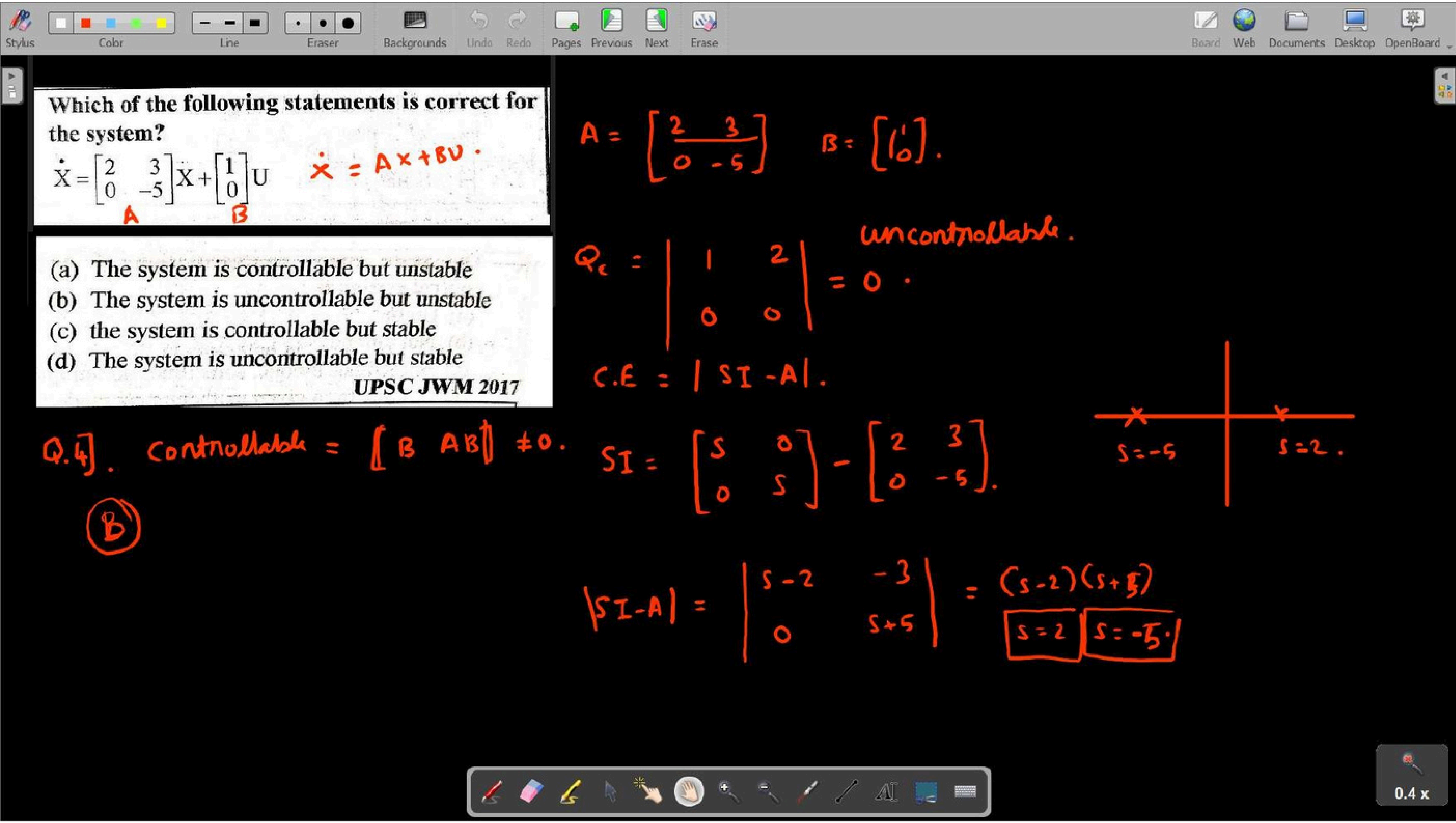

Which of the following statements is correct for the system?

$$\dot{X} = \underbrace{\begin{bmatrix} 2 & 3 \\ 0 & -5 \end{bmatrix}}_{A} X + \underbrace{\begin{bmatrix} 1 \\ 0 \end{bmatrix}}_{B} U \qquad \dot{x} = Ax + BU.$$

(a) The system is controllable but unstable
(b) The system is uncontrollable but unstable
(c) the system is controllable but stable
(d) The system is uncontrollable but stable

UPSC JWM 2017

Q.4]. Controllable = $[B \;\; AB] \neq 0.$

Ⓑ

$$A = \begin{bmatrix} 2 & 3 \\ 0 & -5 \end{bmatrix} \qquad B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$

$$Q_c = \begin{vmatrix} 1 & 2 \\ 0 & 0 \end{vmatrix} = 0.$$

uncontrollable.

$$C.E = |SI - A|.$$

$$SI = \begin{bmatrix} S & 0 \\ 0 & S \end{bmatrix} - \begin{bmatrix} 2 & 3 \\ 0 & -5 \end{bmatrix}.$$

$$|SI - A| = \begin{vmatrix} S-2 & -3 \\ 0 & S+5 \end{vmatrix} = (s-2)(s+5)$$

$$\boxed{s=2} \quad \boxed{s=-5.}$$

$s=-5$ $\quad$ $s=2.$

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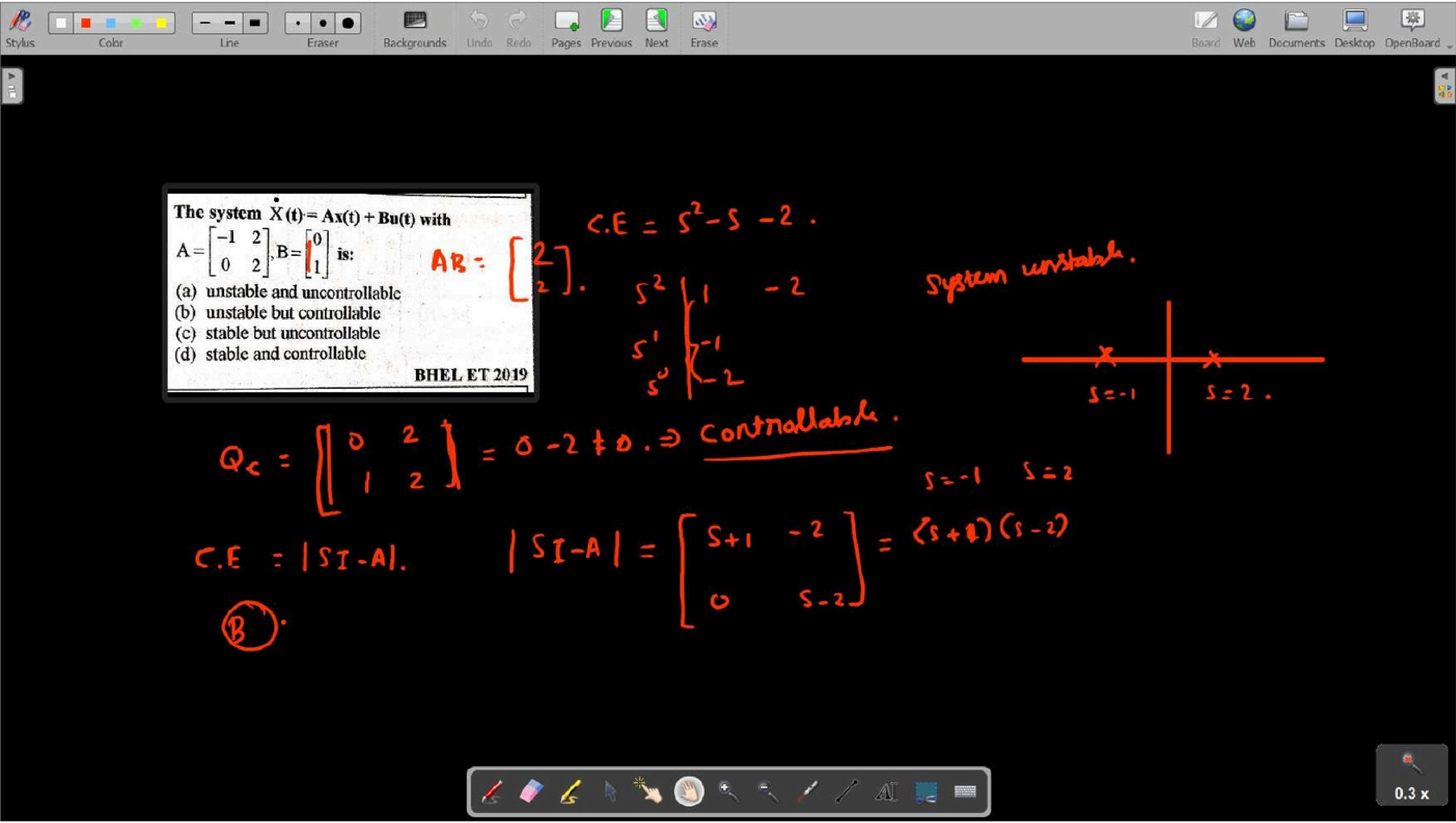

The system $\dot{X}(t) = Ax(t) + Bu(t)$ with $A = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ is:

(a) unstable and uncontrollable

(b) unstable but controllable

(c) stable but uncontrollable

(d) stable and controllable

BHEL ET 2019

$AB = \begin{bmatrix} 2 \\ 2 \end{bmatrix}$.

$C.E = s^2 - s - 2$.

$$\begin{array}{c|cc} s^2 & 1 & -2 \\ s^1 & -1 & \\ s^0 & -2 & \end{array}$$

System unstable.

$s = -1$ $s = 2$.

$Q_c = \begin{bmatrix} 0 & 2 \\ 1 & 2 \end{bmatrix} = 0 - 2 \neq 0. \Rightarrow$ controllable.

$s = -1$ $s = 2$

$C.E = |SI - A|$.

$|SI - A| = \begin{bmatrix} S+1 & -2 \\ 0 & S-2 \end{bmatrix} = (s+1)(s-2)$

Ⓑ.

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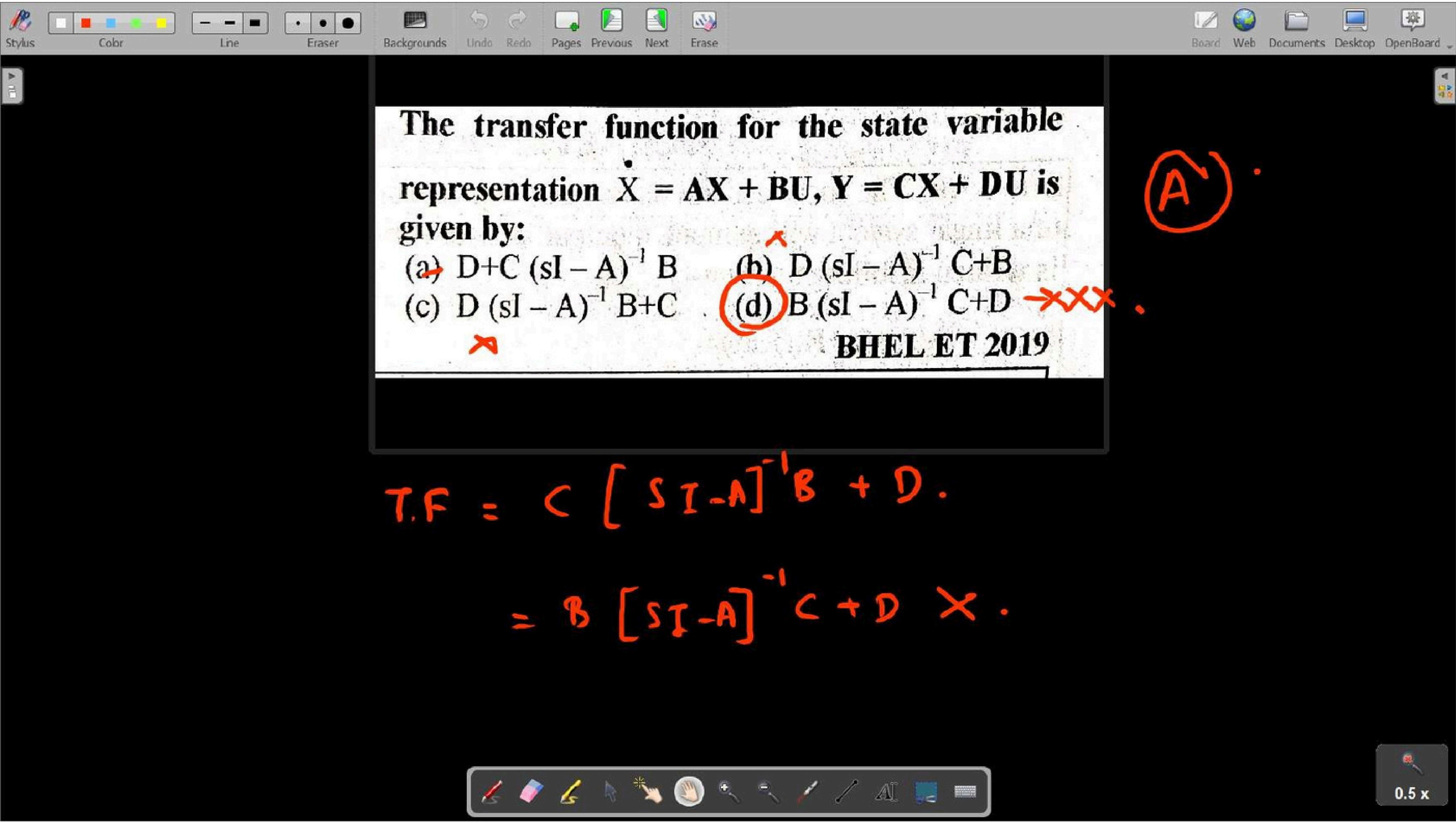

The transfer function for the state variable representation $\dot{X} = AX + BU, Y = CX + DU$ is given by:

(a) $D+C(sI-A)^{-1}B$ (b) $D(sI-A)^{-1}C+B$

(c) $D(sI-A)^{-1}B+C$ [✓ (d)] $B(sI-A)^{-1}C+D$ → xxx

BHEL ET 2019

Ⓐ

$$T.F = C\left[sI-A\right]^{-1}B + D.$$

$$= B\left[sI-A\right]^{-1}C + D \times .$$

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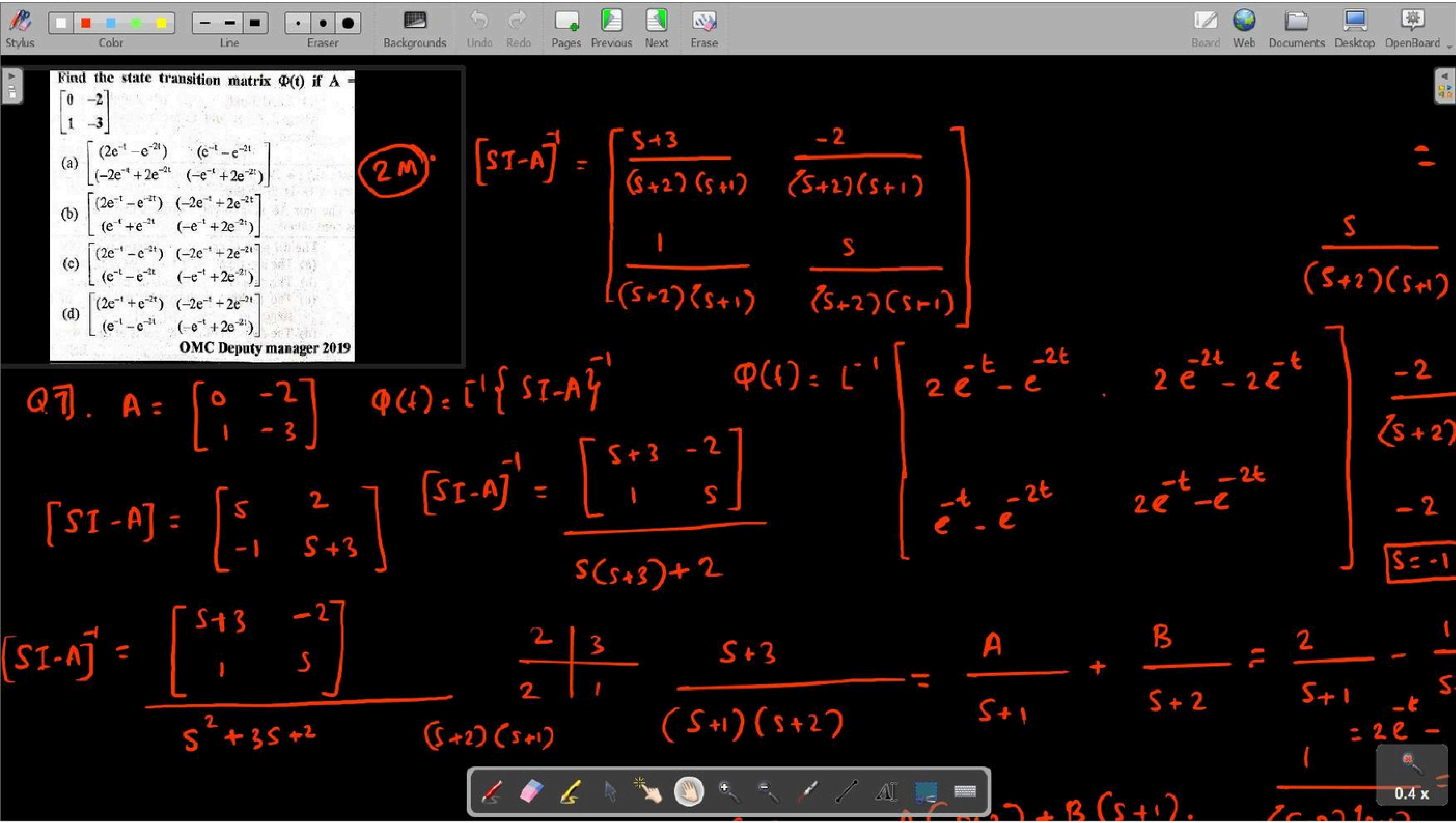

Find the state transition matrix $\Phi(t)$ if $A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$

(a) $\begin{bmatrix} (2e^{-t} - e^{-2t}) & (e^{-t} - e^{-2t} \\ (-2e^{-t} + 2e^{-2t} & (-e^{-t} + 2e^{-2t}) \end{bmatrix}$

(b) $\begin{bmatrix} (2e^{-t} - e^{-2t}) & (-2e^{-t} + 2e^{-2t} \\ (e^{-t} + e^{-2t} & (-e^{-t} + 2e^{-2t}) \end{bmatrix}$

(c) $\begin{bmatrix} (2e^{-t} - e^{-2t}) & (-2e^{-t} + 2e^{-2t} \\ (e^{-t} - e^{-2t} & (-e^{-t} + 2e^{-2t}) \end{bmatrix}$

(d) $\begin{bmatrix} (2e^{-t} + e^{-2t}) & (-2e^{-t} + 2e^{-2t} \\ (e^{-t} - e^{-2t} & (-e^{-t} + 2e^{-2t}) \end{bmatrix}$

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$\boxed{2M}$

Q7. $A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$

$\phi(t) = L^{-1}\{SI - A\}^{-1}$

$[SI - A] = \begin{bmatrix} S & 2 \\ -1 & S+3 \end{bmatrix}$

$[SI-A]^{-1} = \dfrac{\begin{bmatrix} S+3 & -2 \\ 1 & S \end{bmatrix}}{S(S+3)+2}$

$[SI-A]^{-1} = \dfrac{\begin{bmatrix} S+3 & -2 \\ 1 & S \end{bmatrix}}{S^2+3S+2}$

$$\begin{array}{c|c} 2 & 3 \\ \hline 2 & 1 \end{array}$$

$(S+2)(S+1)$

$[SI-A]^{-1} = \begin{bmatrix} \dfrac{S+3}{(S+2)(S+1)} & \dfrac{-2}{(S+2)(S+1)} \\ \dfrac{1}{(S+2)(S+1)} & \dfrac{S}{(S+2)(S+1)} \end{bmatrix}$

$\phi(t) = L^{-1}\begin{bmatrix} 2e^{-t} - e^{-2t} & 2e^{-2t} - 2e^{-t} \\ e^{-t} - e^{-2t} & 2e^{-t} - e^{-2t} \end{bmatrix}$

$\dfrac{S+3}{(S+1)(S+2)} = \dfrac{A}{S+1} + \dfrac{B}{S+2} = \dfrac{2}{S+1} - \dfrac{1}{S}$

$= 2e^{-t} -$

$=$

$\dfrac{S}{(S+2)(S+1)}$

$\dfrac{-2}{(S+2)}$

-2

$\boxed{S = -1}$

1

$A(S+2) + B(S+1).$

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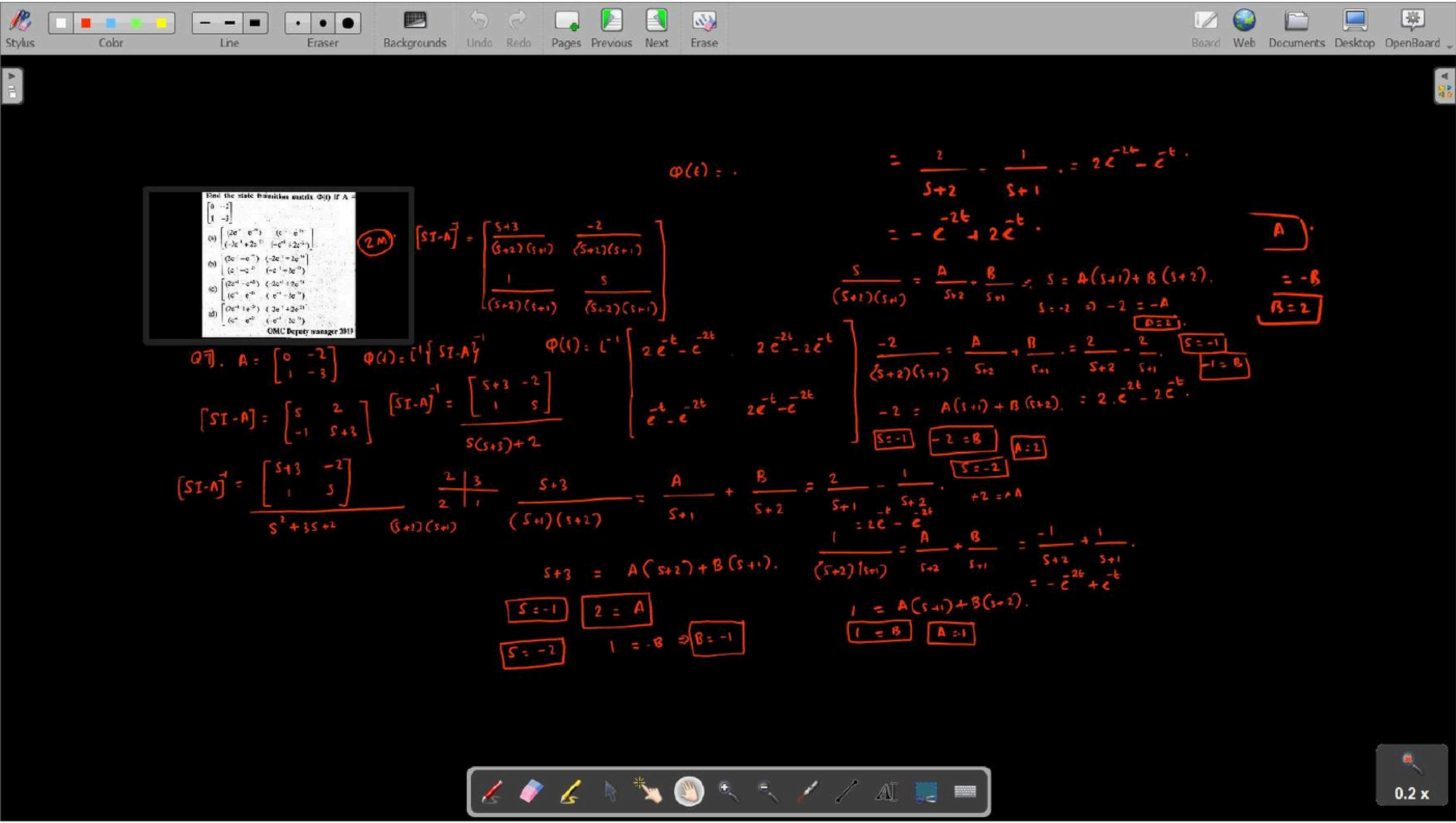


Find the state transition matrix $\Phi(t)$ if $A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$

OMC Deputy manager 2019

$\textcircled{2M}$

Q7. $A = \begin{bmatrix} 0 & -2 \\ 1 & -3 \end{bmatrix}$ $\Phi(t) = L^{-1}\{SI-A\}^{-1}$

$[SI-A] = \begin{bmatrix} S & 2 \\ -1 & S+3 \end{bmatrix}$ $[SI-A]^{-1} = \dfrac{\begin{bmatrix} S+3 & -2 \\ 1 & S \end{bmatrix}}{S(S+3)+2}$

$[SI-A]^{-1} = \dfrac{\begin{bmatrix} S+3 & -2 \\ 1 & S \end{bmatrix}}{S^2+3S+2}$ $\begin{array}{c|c} 2 & 3 \\ \hline 2 & 1 \end{array}$ $(S+2)(S+1)$

$[SI-A]^{-1} = \begin{bmatrix} \dfrac{S+3}{(S+2)(S+1)} & \dfrac{-2}{(S+2)(S+1)} \\ \dfrac{1}{(S+2)(S+1)} & \dfrac{S}{(S+2)(S+1)} \end{bmatrix}$

$\Phi(t) = L^{-1}\begin{bmatrix} 2e^{-t} - e^{-2t} & 2e^{-2t} - 2e^{-t} \\ e^{-t} - e^{-2t} & 2e^{-t} - e^{-2t} \end{bmatrix}$

$\Phi(t) = .$

$\dfrac{S+3}{(S+1)(S+2)} = \dfrac{A}{S+1} + \dfrac{B}{S+2} = \dfrac{2}{S+1} - \dfrac{1}{S+2}.$

$= 2e^{-t} - e^{-2t}$

$S+3 = A(S+2) + B(S+1).$

$\boxed{S=-1}$ $\boxed{2 = A}$

$\boxed{S=-2}$ $1 = -B \Rightarrow \boxed{B=-1}$

$\dfrac{1}{(S+2)(S+1)} = \dfrac{A}{S+2} + \dfrac{B}{S+1} = \dfrac{-1}{S+2} + \dfrac{1}{S+1}.$

$= -e^{-2t} + e^{-t}$

$1 = A(S+1) + B(S+2).$

$\boxed{1 = B}$ $\boxed{A=-1}$

$\dfrac{-2}{(S+2)(S+1)} = \dfrac{A}{S+2} + \dfrac{B}{S+1}. = \dfrac{2}{S+2} - \dfrac{2}{S+1}.$ $\boxed{S=-1}$ $\boxed{-1 = B}$

$-2 = A(S+1) + B(S+2).$ $= 2.e^{-2t} - 2e^{-t}.$

$\boxed{S=-1}$ $\boxed{-2 = B}$ $\boxed{A=2}$

$\boxed{S=-2}$

$+2 = +A$

$\dfrac{S}{(S+2)(S+1)} = \dfrac{A}{S+2} + \dfrac{B}{S+1}$ $S = A(S+1) + B(S+2).$

$S=-2 \Rightarrow -2 = -A$

$\boxed{A=2}.$

$= -B$

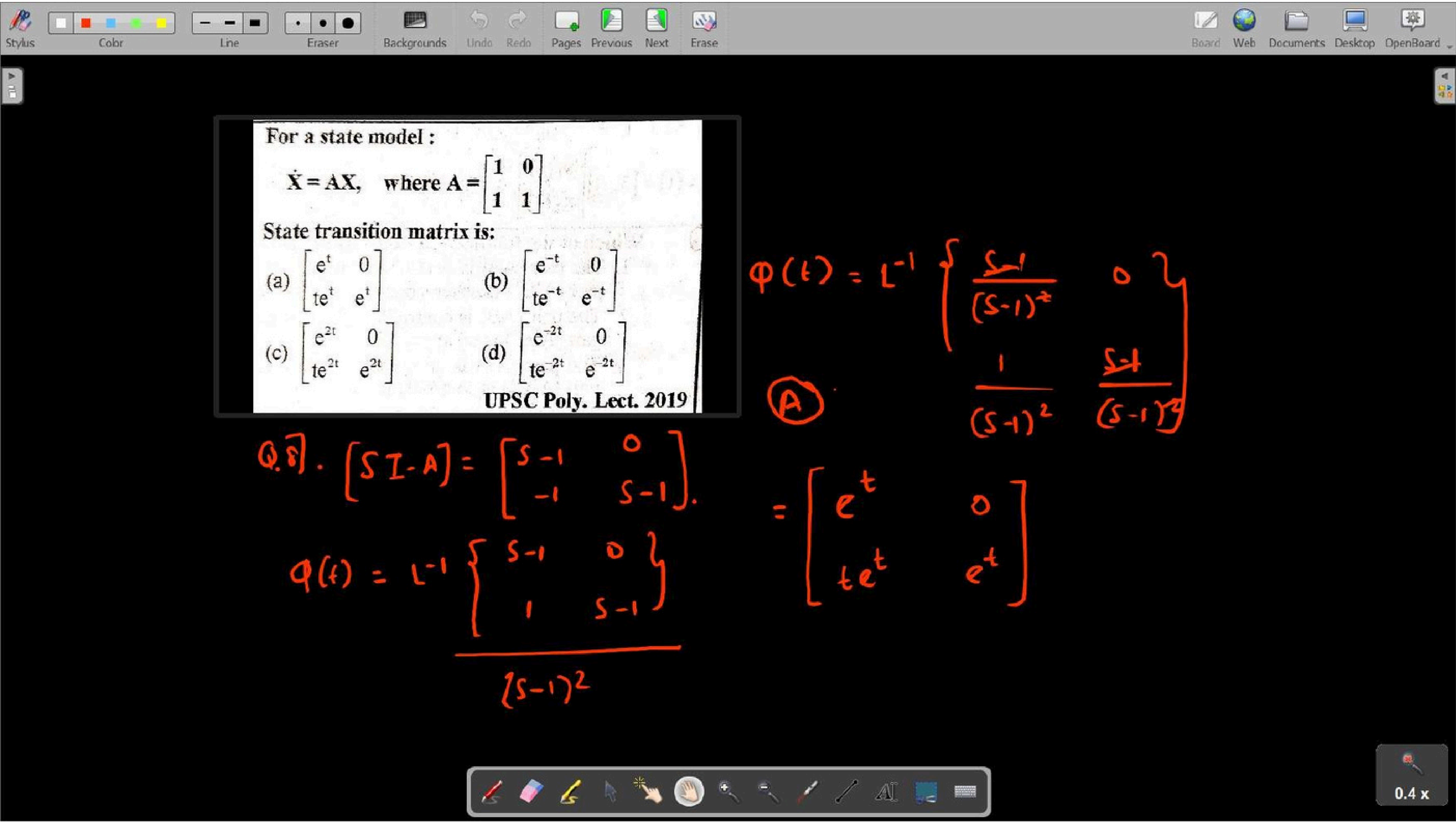
$\boxed{B=2}$

$\boxed{A}.$

$= \dfrac{2}{S+2} - \dfrac{1}{S+1}. = 2e^{-2t} - e^{-t}.$

$= -e^{-2t} + 2e^{-t}.$

Full Video Link



For a state model :

$$\dot{X} = AX, \quad \text{where } A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$

State transition matrix is:

(a) $\begin{bmatrix} e^{t} & 0 \\ te^{t} & e^{t} \end{bmatrix}$ (b) $\begin{bmatrix} e^{-t} & 0 \\ te^{-t} & e^{-t} \end{bmatrix}$

(c) $\begin{bmatrix} e^{2t} & 0 \\ te^{2t} & e^{2t} \end{bmatrix}$ (d) $\begin{bmatrix} e^{-2t} & 0 \\ te^{-2t} & e^{-2t} \end{bmatrix}$

UPSC Poly. Lect. 2019

Q.8]. $[SI - A] = \begin{bmatrix} S-1 & 0 \\ -1 & S-1 \end{bmatrix}.$

$$\phi(t) = L^{-1}\left\{\frac{\begin{bmatrix} S-1 & 0 \\ 1 & S-1 \end{bmatrix}}{(S-1)^2}\right\}$$

$$\phi(t) = L^{-1}\left\{\begin{matrix} \frac{S-1}{(S-1)^2} & 0 \\ \frac{1}{(S-1)^2} & \frac{S-1}{(S-1)^2} \end{matrix}\right\}$$

Ⓐ

$$= \begin{bmatrix} e^{t} & 0 \\ te^{t} & e^{t} \end{bmatrix}$$

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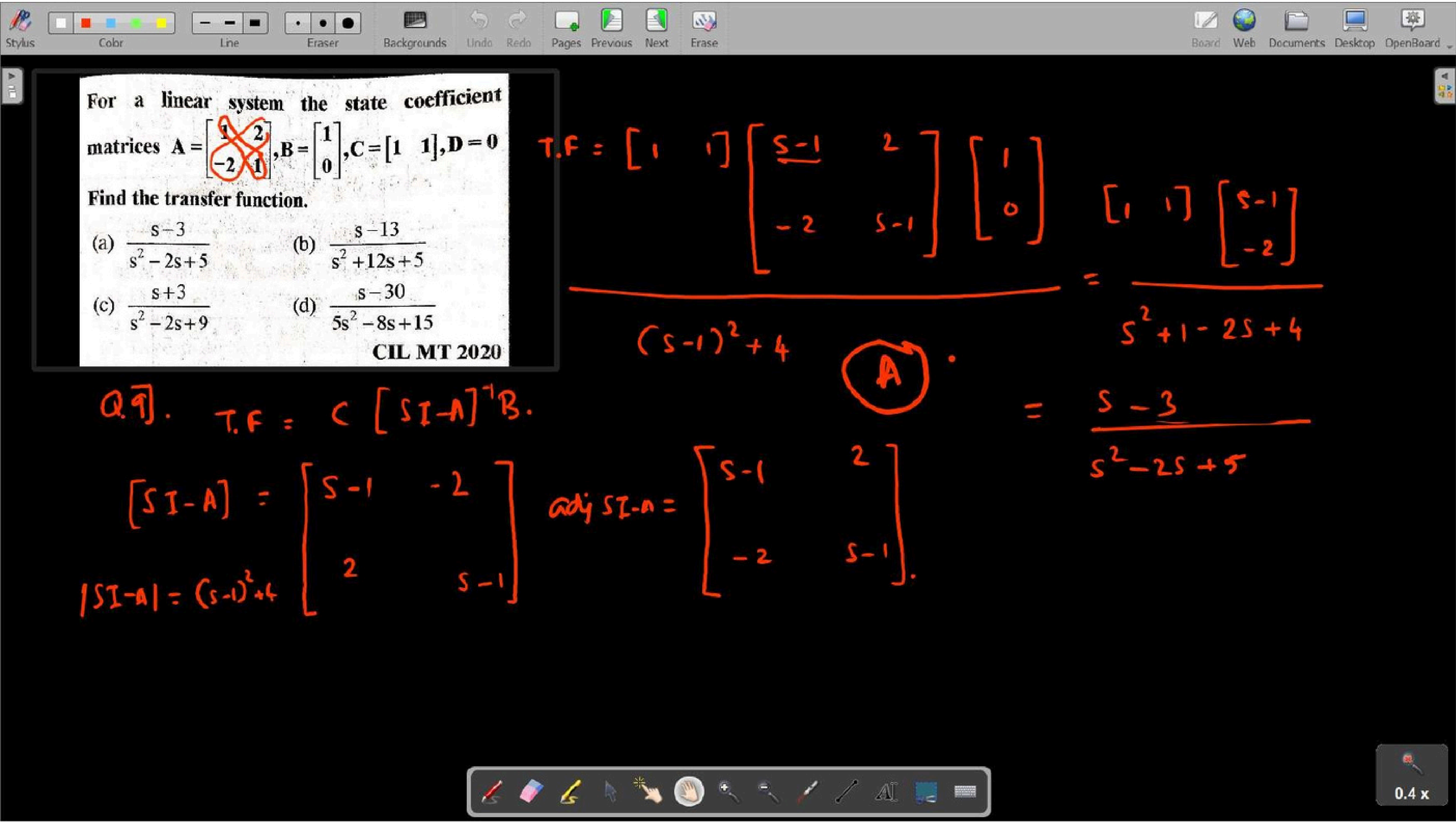


For a linear system the state coefficient matrices $A=\begin{bmatrix}1 & 2\\ -2 & 1\end{bmatrix}$, $B=\begin{bmatrix}1\\ 0\end{bmatrix}$, $C=[1\ \ 1]$, $D=0$

Find the transfer function.

(a) $\frac{s-3}{s^2-2s+5}$ (b) $\frac{s-13}{s^2+12s+5}$

(c) $\frac{s+3}{s^2-2s+9}$ (d) $\frac{s-30}{5s^2-8s+15}$

CIL MT 2020

Q.9]. $T.F = C\,[SI-A]^{-1}B.$

$$[SI-A] = \begin{bmatrix}s-1 & -2\\ 2 & s-1\end{bmatrix}$$

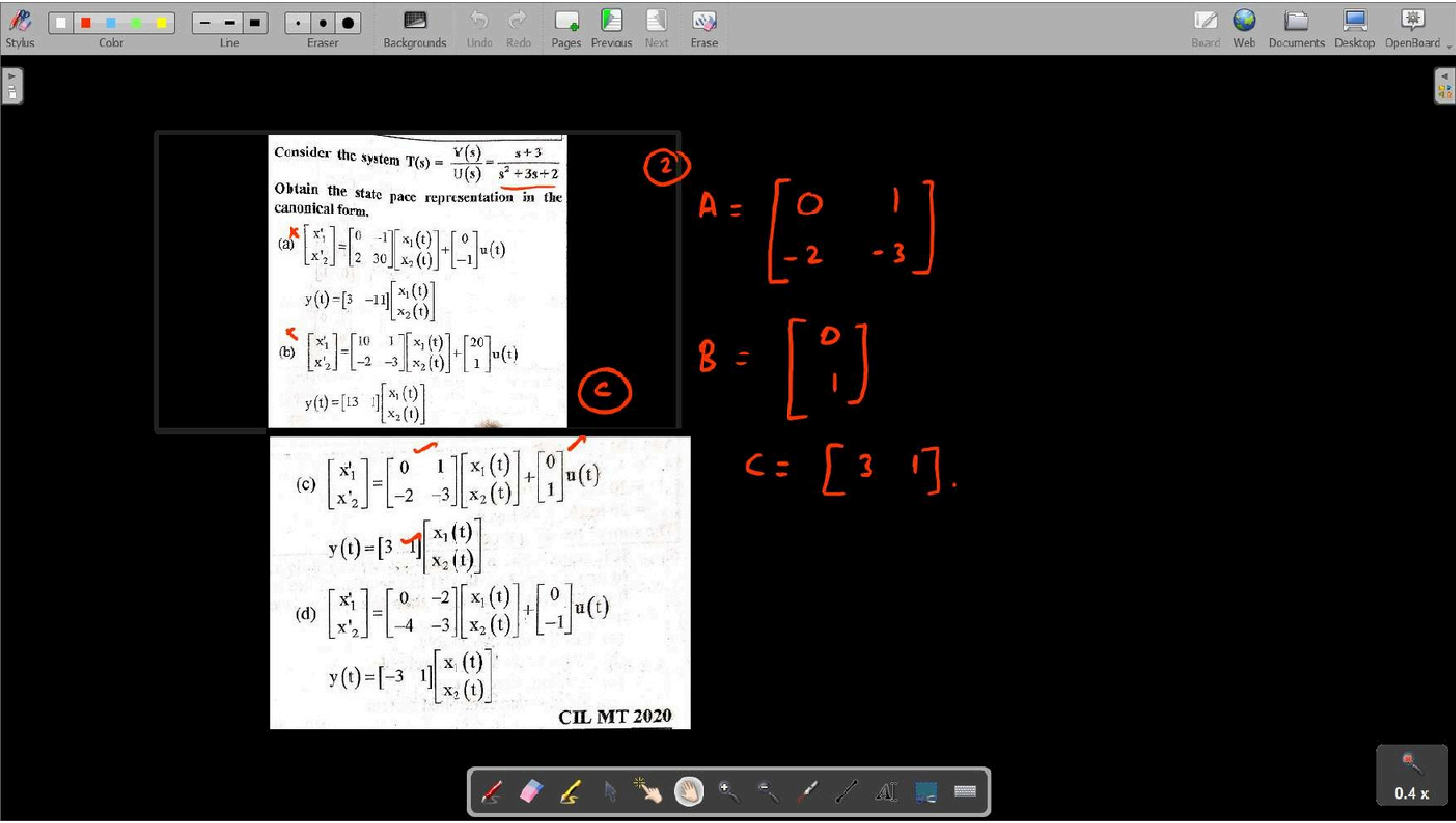
$$|SI-A| = (s-1)^2+4$$

$$\text{adj } SI-A = \begin{bmatrix}s-1 & 2\\ -2 & s-1\end{bmatrix}.$$

$$T.F = \frac{[1\ \ 1]\begin{bmatrix}s-1 & 2\\ -2 & s-1\end{bmatrix}\begin{bmatrix}1\\ 0\end{bmatrix}}{(s-1)^2+4} = \frac{[1\ \ 1]\begin{bmatrix}s-1\\ -2\end{bmatrix}}{s^2+1-2s+4} = \frac{s-3}{s^2-2s+5}$$

$\boxed{A}$.

Full Video Link



Consider the system $T(s) = \frac{Y(s)}{U(s)} = \frac{s+3}{\underline{s^2+3s+2}}$

Obtain the state pace representation in the canonical form.

②

(a) ✗ $\begin{bmatrix} x'_1 \\ x'_2 \end{bmatrix} = \begin{bmatrix} 0 & -1 \\ 2 & 30 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ -1 \end{bmatrix} u(t)$

$y(t) = [3 \quad -11] \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$

(b) $\begin{bmatrix} x'_1 \\ x'_2 \end{bmatrix} = \begin{bmatrix} 10 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 20 \\ 1 \end{bmatrix} u(t)$

$y(t) = [13 \quad 1] \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$

ⓒ

(c) $\begin{bmatrix} x'_1 \\ x'_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$

$y(t) = [3 \quad 1] \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$

(d) $\begin{bmatrix} x'_1 \\ x'_2 \end{bmatrix} = \begin{bmatrix} 0 & -2 \\ -4 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ -1 \end{bmatrix} u(t)$

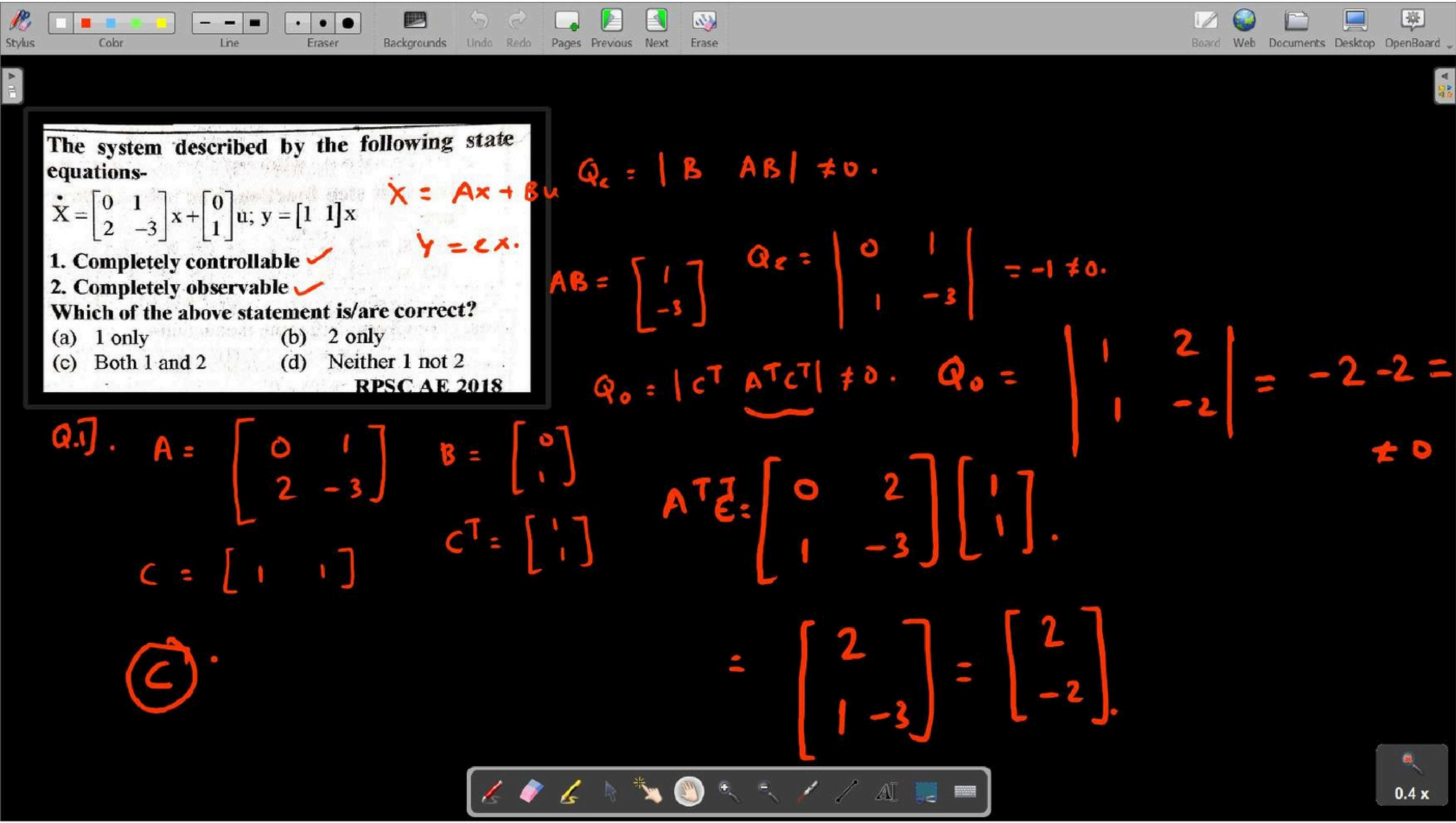
$y(t) = [-3 \quad 1] \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$

CIL MT 2020

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$$

$$B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$C = [3 \quad 1].$$



The system described by the following state equations-

$$\dot{X} = \begin{bmatrix}0 & 1\\ 2 & -3\end{bmatrix}x + \begin{bmatrix}0\\ 1\end{bmatrix}u;\ y = [1\ \ 1]x$$

1. Completely controllable ✓
2. Completely observable ✓

Which of the above statement is/are correct?

(a) 1 only (b) 2 only
(c) Both 1 and 2 (d) Neither 1 not 2

RPSC AE 2018

$\dot{x} = Ax + Bu$

$y = cx.$

$Q_c = |B \quad AB| \neq 0.$

$AB = \begin{bmatrix}1\\ -3\end{bmatrix}$ $Q_c = \begin{vmatrix}0 & 1\\ 1 & -3\end{vmatrix} = -1 \neq 0.$

$Q_0 = |c^T \quad \underbrace{A^Tc^T}| \neq 0.$ $Q_0 = \begin{vmatrix}1 & 2\\ 1 & -2\end{vmatrix} = -2-2 =$ $\neq 0$

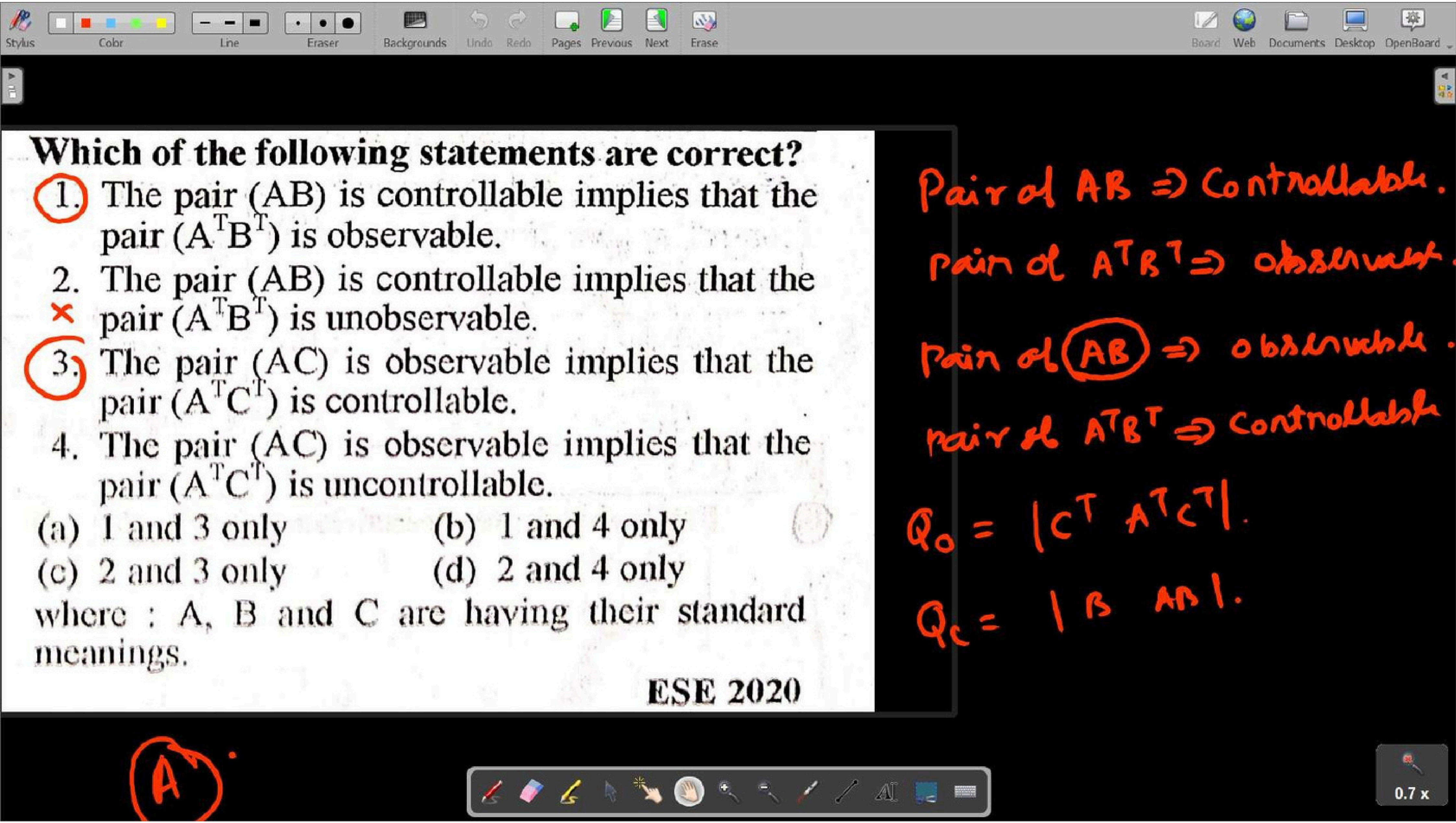
Q.1. $A = \begin{bmatrix}0 & 1\\ 2 & -3\end{bmatrix}$ $B = \begin{bmatrix}0\\ 1\end{bmatrix}$

$C = [1 \quad 1]$ $C^T = \begin{bmatrix}1\\ 1\end{bmatrix}$

$A^Tc^T = \begin{bmatrix}0 & 2\\ 1 & -3\end{bmatrix}\begin{bmatrix}1\\ 1\end{bmatrix}.$

$= \begin{bmatrix}2\\ 1-3\end{bmatrix} = \begin{bmatrix}2\\ -2\end{bmatrix}.$

ⓒ.



Which of the following statements are correct?

1. The pair (AB) is controllable implies that the pair (A^TB^T) is observable.
2. The pair (AB) is controllable implies that the pair (A^TB^T) is unobservable. ×
3. The pair (AC) is observable implies that the pair (A^TC^T) is controllable.
4. The pair (AC) is observable implies that the pair (A^TC^T) is uncontrollable.

(a) 1 and 3 only
(b) 1 and 4 only
(c) 2 and 3 only
(d) 2 and 4 only

where : A, B and C are having their standard meanings.

ESE 2020

Pair of AB ⇒ Controllable.

pair of A^TB^T ⇒ observable.

Pair of $\boxed{AB}$ ⇒ observable.

pair of A^TB^T ⇒ controllable

$Q_o = |C^T \; A^TC^T|$.

$Q_c = |B \quad AB|$.

(A).

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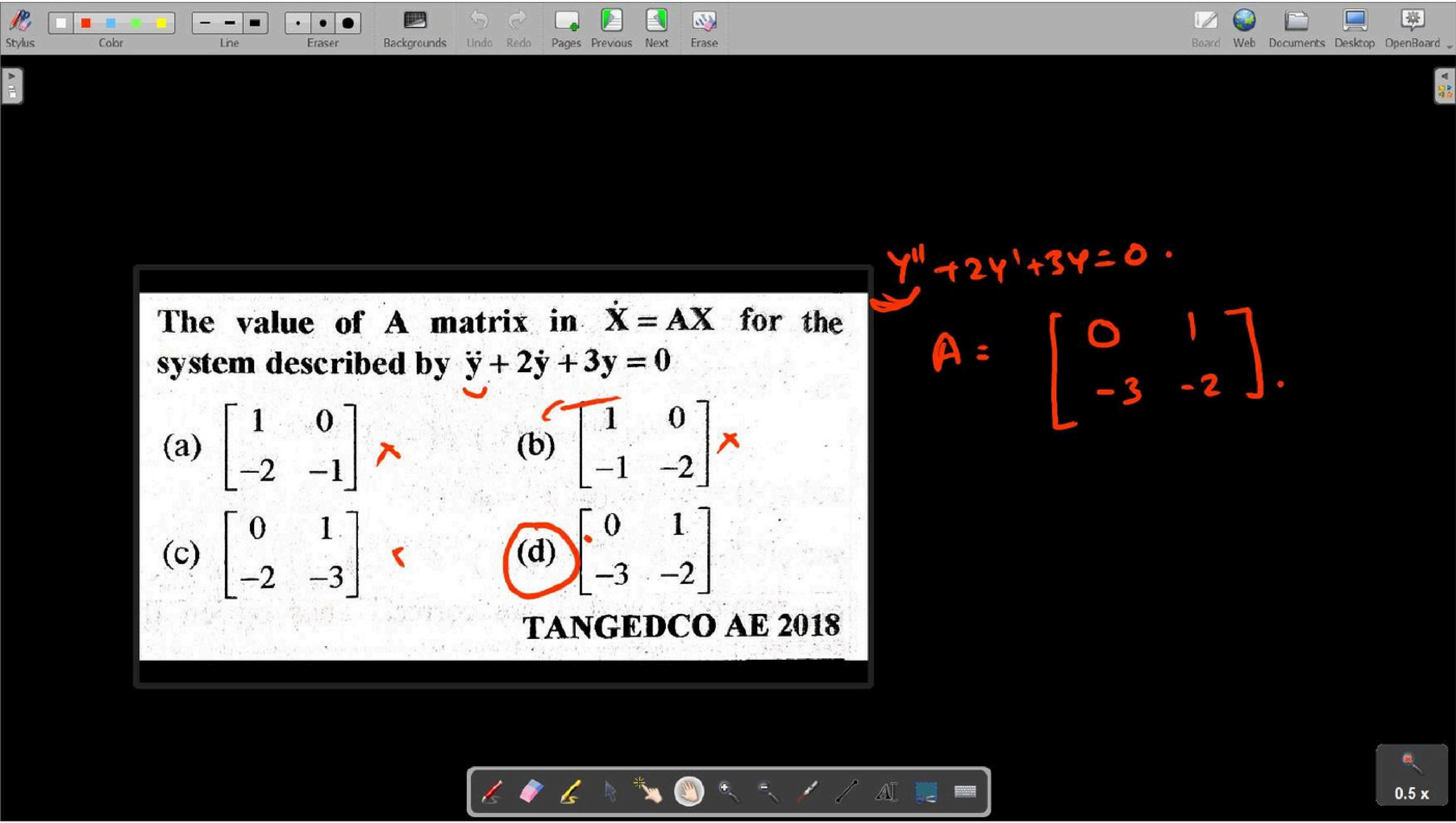

The value of A matrix in $\dot{X} = AX$ for the system described by $\ddot{y} + 2\dot{y} + 3y = 0$

(a) $\begin{bmatrix} 1 & 0 \\ -2 & -1 \end{bmatrix}$ ✗

(b) $\begin{bmatrix} 1 & 0 \\ -1 & -2 \end{bmatrix}$ ✗

(c) $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$

[✓ (d)] $\begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix}$

TANGEDCO AE 2018

$y'' + 2y' + 3y = 0.$

$A = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix}.$

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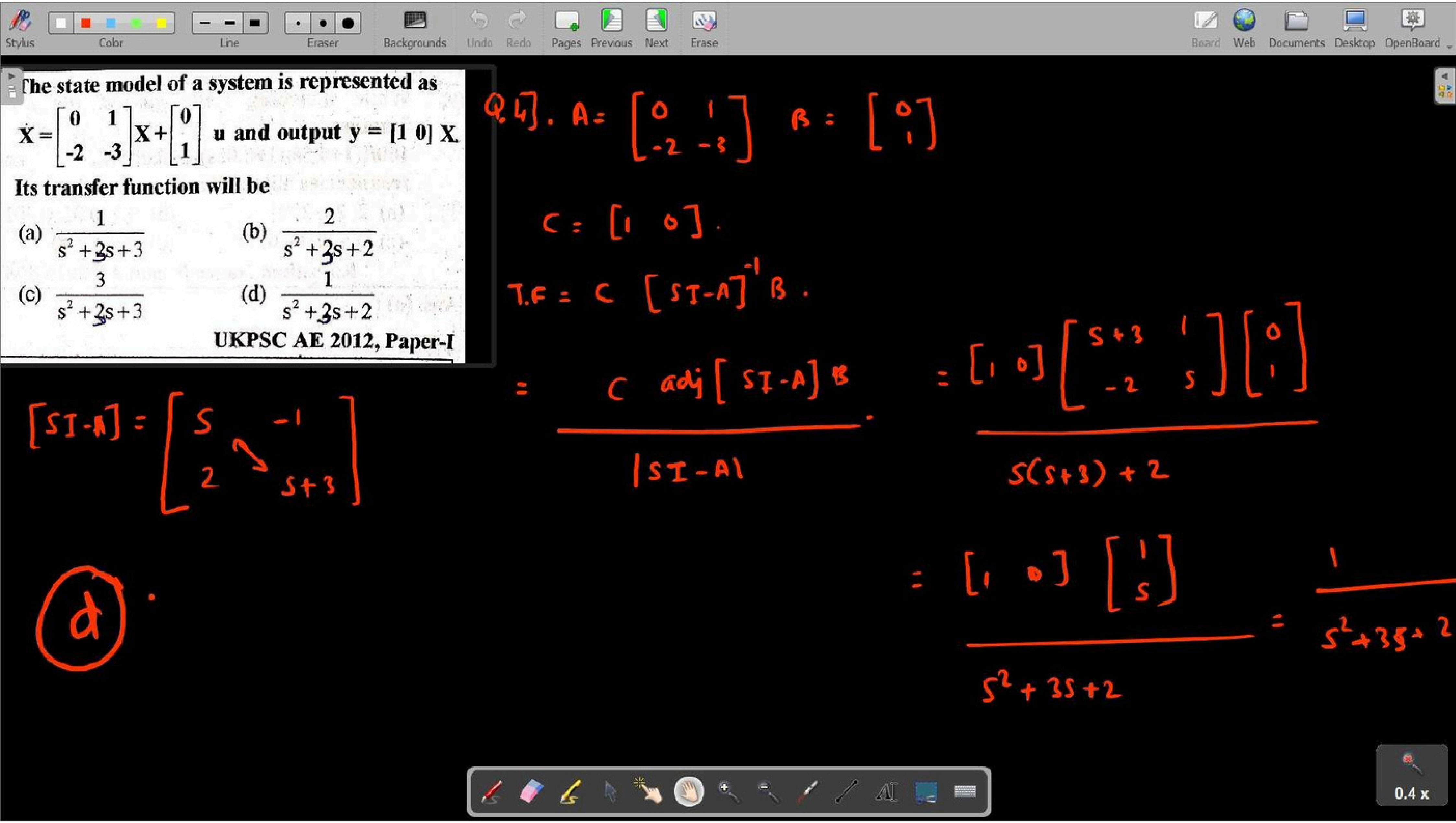


The state model of a system is represented as

$\dot{X} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ u and output y = [1 0] X.

Its transfer function will be

(a) $\frac{1}{s^2+\underset{3}{2}s+3}$ (b) $\frac{2}{s^2+\underset{3}{2}s+2}$

(c) $\frac{3}{s^2+\underset{3}{2}s+3}$ (d) $\frac{1}{s^2+\underset{3}{2}s+2}$

UKPSC AE 2012, Paper-I

Q.4]. $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$

$C = [1 \quad 0]$.

$T.F = C\,[sI-A]^{-1}B$.

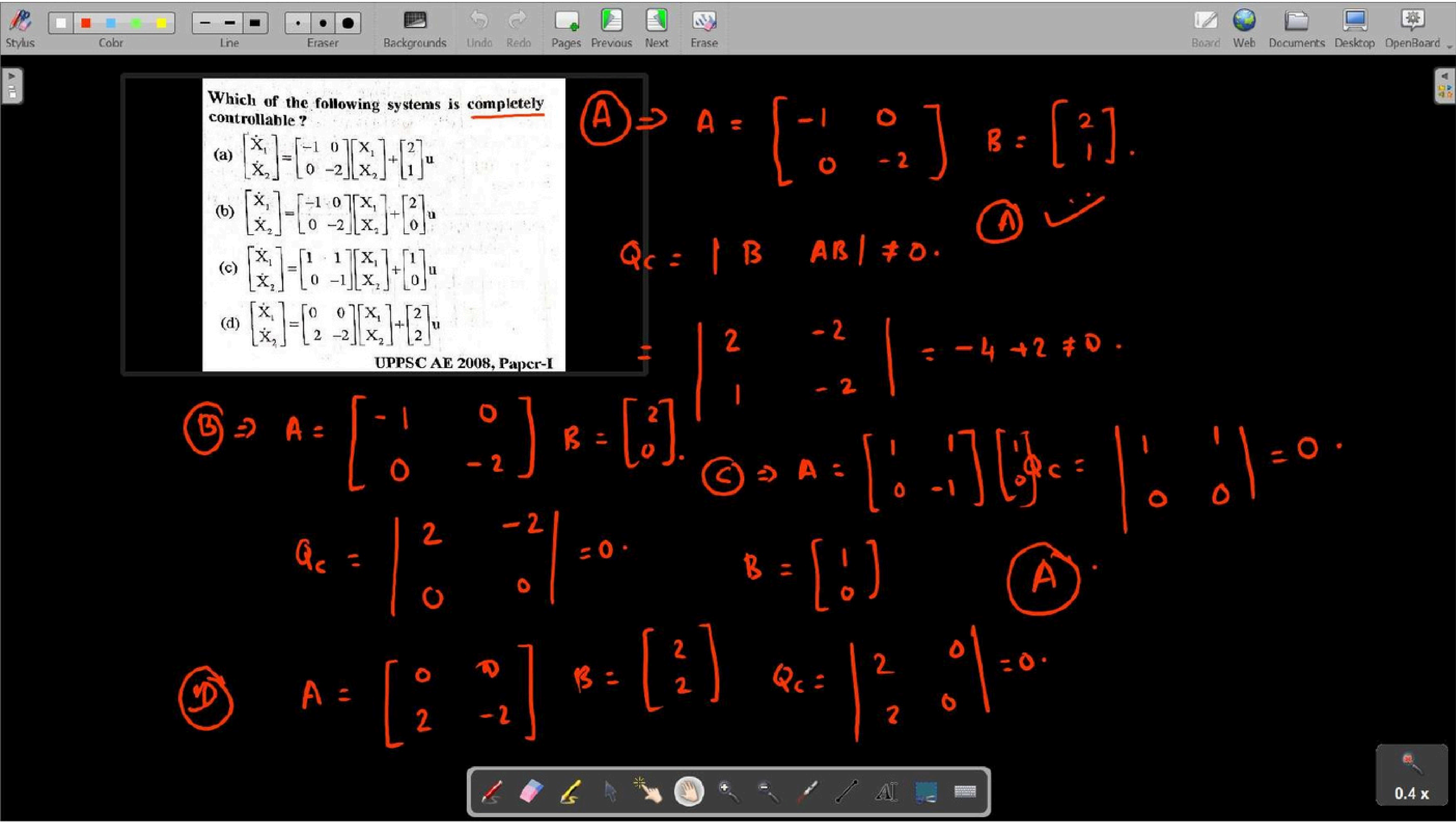
$= \frac{C \text{ adj}[sI-A]\,B}{|sI-A|} = \frac{[1 \quad 0]\begin{bmatrix} s+3 & 1 \\ -2 & s \end{bmatrix}\begin{bmatrix} 0 \\ 1 \end{bmatrix}}{s(s+3)+2}$

$[sI-A] = \begin{bmatrix} s & -1 \\ 2 & s+3 \end{bmatrix}$

$= \frac{[1 \quad 0]\begin{bmatrix} 1 \\ s \end{bmatrix}}{s^2+3s+2} = \frac{1}{s^2+3s+2}$

$\textcircled{d}$.

Full Video Link



Which of the following systems is completely controllable ?

(a) $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\begin{bmatrix}2\\ 1\end{bmatrix}u$

(b) $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\begin{bmatrix}2\\ 0\end{bmatrix}u$

(c) $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\begin{bmatrix}1 & 1\\ 0 & -1\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\begin{bmatrix}1\\ 0\end{bmatrix}u$

(d) $\begin{bmatrix}\dot{X}_1\\ \dot{X}_2\end{bmatrix}=\begin{bmatrix}0 & 0\\ 2 & -2\end{bmatrix}\begin{bmatrix}X_1\\ X_2\end{bmatrix}+\begin{bmatrix}2\\ 2\end{bmatrix}u$

UPPSC AE 2008, Paper-I

Ⓐ $\Rightarrow A = \begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix} \quad B = \begin{bmatrix}2\\ 1\end{bmatrix}.$

$Q_c = |B \quad AB| \neq 0.$

$= \begin{vmatrix}2 & -2\\ 1 & -2\end{vmatrix} = -4+2 \neq 0.$

Ⓐ ✓

Ⓑ $\Rightarrow A = \begin{bmatrix}-1 & 0\\ 0 & -2\end{bmatrix} \quad B = \begin{bmatrix}2\\ 0\end{bmatrix}.$

$Q_c = \begin{vmatrix}2 & -2\\ 0 & 0\end{vmatrix} = 0.$

Ⓒ $\Rightarrow A = \begin{bmatrix}1 & 1\\ 0 & -1\end{bmatrix} \begin{bmatrix}1\\ 0\end{bmatrix} \quad Q_c = \begin{vmatrix}1 & 1\\ 0 & 0\end{vmatrix} = 0.$

$B = \begin{bmatrix}1\\ 0\end{bmatrix}$

Ⓐ.

Ⓓ $A = \begin{bmatrix}0 & 0\\ 2 & -2\end{bmatrix} \quad B = \begin{bmatrix}2\\ 2\end{bmatrix} \quad Q_c = \begin{vmatrix}2 & 0\\ 2 & 0\end{vmatrix} = 0.$

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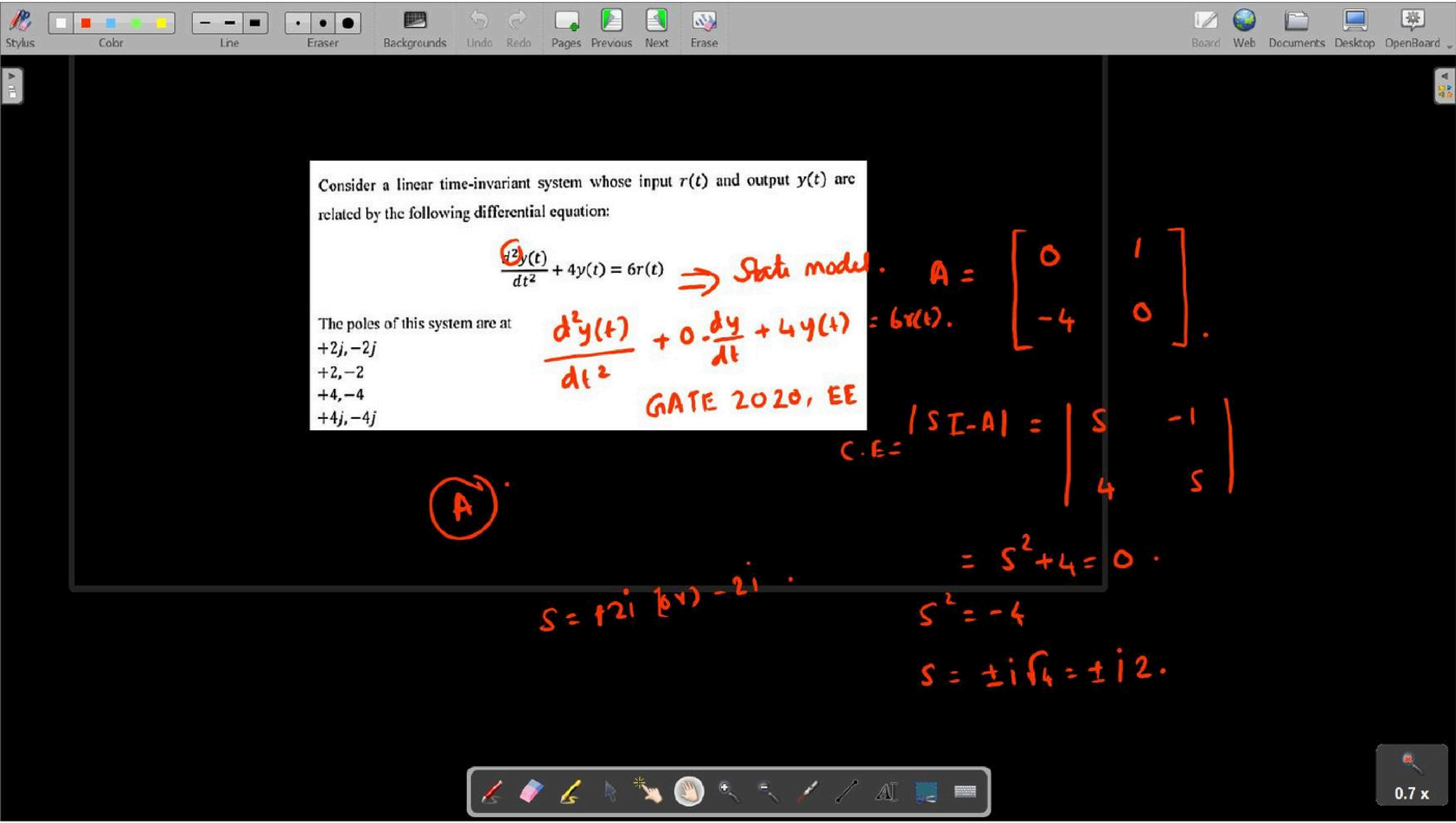


Consider a linear time-invariant system whose input $r(t)$ and output $y(t)$ are related by the following differential equation:

$$\frac{d^2y(t)}{dt^2} + 4y(t) = 6r(t) \Rightarrow \text{State model.}$$

The poles of this system are at

+2j, −2j

+2, −2

+4, −4

+4j, −4j

$$\frac{d^2y(t)}{dt^2} + 0.\frac{dy}{dt} + 4y(t) = 6r(t).$$

GATE 2020, EE

$$A = \begin{bmatrix} 0 & 1 \\ -4 & 0 \end{bmatrix}.$$

$$C.E = |sI-A| = \begin{vmatrix} s & -1 \\ 4 & s \end{vmatrix}$$

$$= s^2+4=0.$$

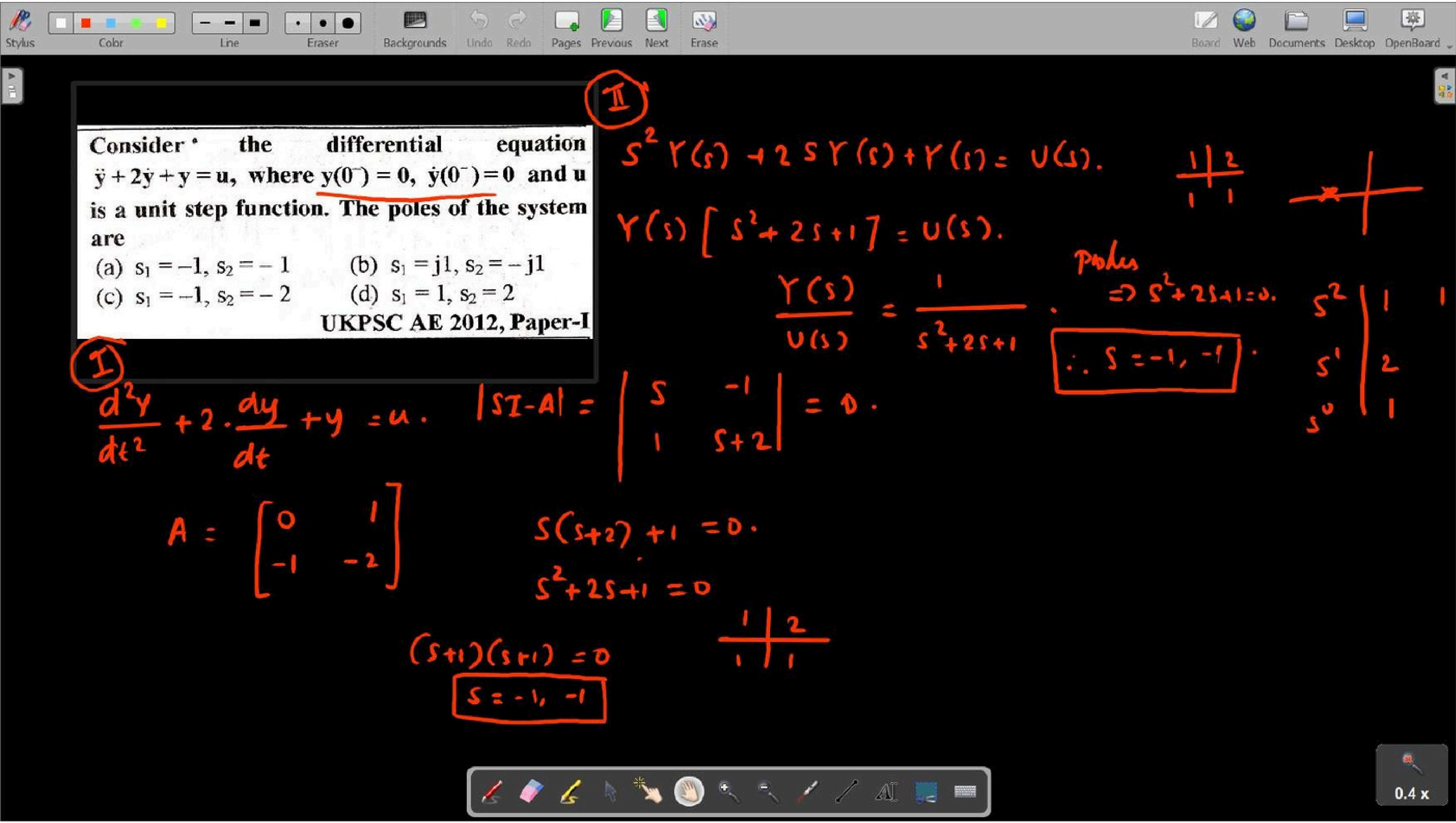
$$s^2=-4$$

$$s = \pm i\sqrt{4} = \pm i2.$$

$$s = +2i \text{ (or) } -2i.$$

Ⓐ.

Full Video Link



Consider the differential equation $\ddot{y}+2\dot{y}+y=u$, where $y(0^-)=0$, $\dot{y}(0^-)=0$ and u is a unit step function. The poles of the system are

(a) $s_1=-1, s_2=-1$ (b) $s_1=j1, s_2=-j1$

(c) $s_1=-1, s_2=-2$ (d) $s_1=1, s_2=2$

UKPSC AE 2012, Paper-I

Ⅰ

$$\frac{d^2y}{dt^2}+2\cdot\frac{dy}{dt}+y=u.$$

$$|sI-A| = \begin{vmatrix} s & -1\\ 1 & s+2\end{vmatrix} = 0.$$

$$A = \begin{bmatrix} 0 & 1\\ -1 & -2\end{bmatrix}$$

$$s(s+2)+1=0.$$

$$s^2+2s+1=0$$

$$(s+1)(s+1)=0$$

$$\boxed{s=-1,-1}$$

Ⅱ

$$s^2Y(s)+2sY(s)+Y(s)=U(s).$$

$$Y(s)[s^2+2s+1]=U(s).$$

$$\frac{Y(s)}{U(s)}=\frac{1}{s^2+2s+1}.$$

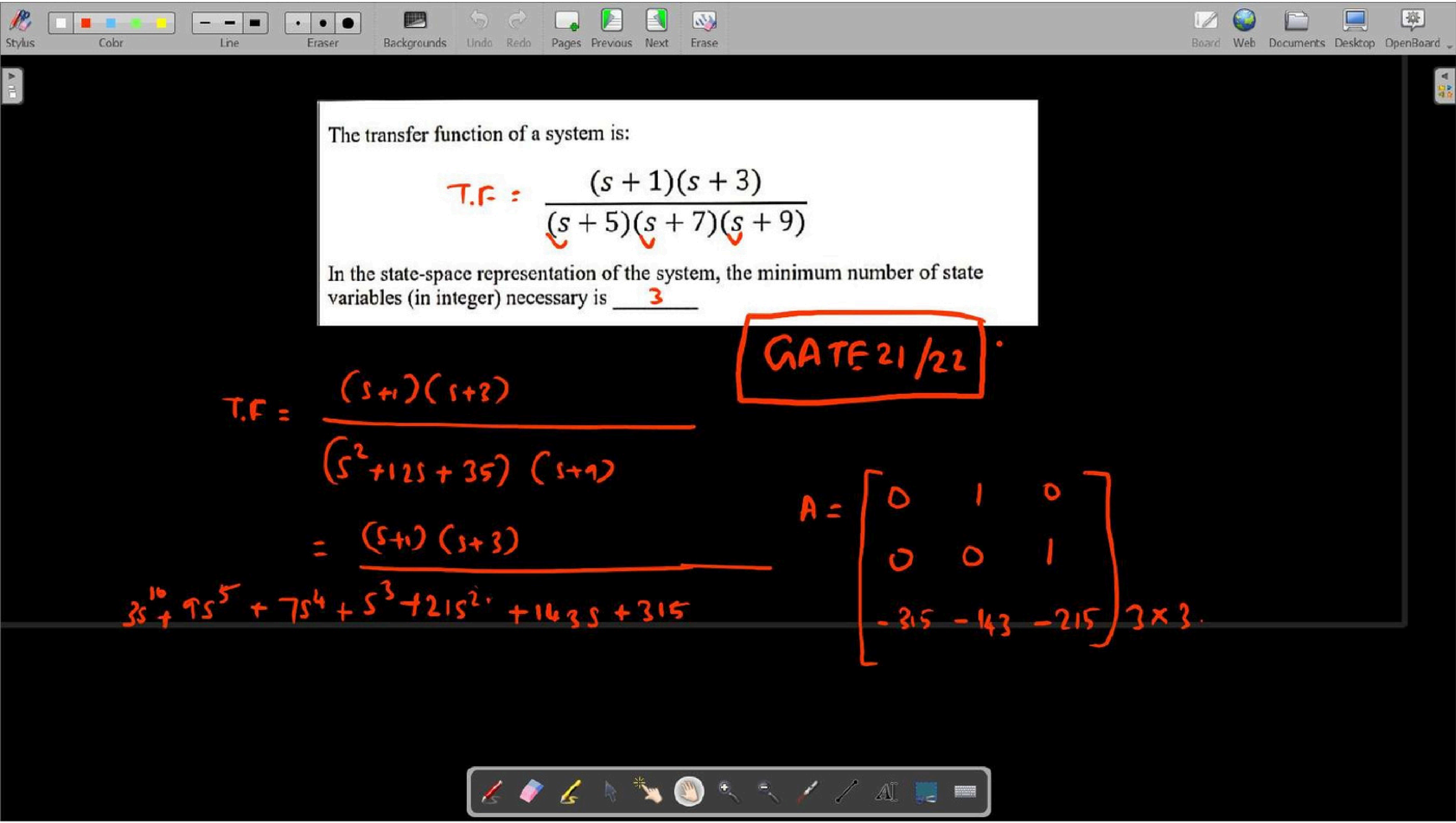
Poles

$$\Rightarrow s^2+2s+1=0.$$

$$\boxed{\therefore s=-1,-1}.$$

$$\begin{array}{c|cc} s^2 & 1 & 1\\ s^1 & 2 & \\ s^0 & 1 & \end{array}$$

Full Video Link



The transfer function of a system is:

$$T.F = \frac{(s+1)(s+3)}{(s+5)(s+7)(s+9)}$$

In the state-space representation of the system, the minimum number of state variables (in integer) necessary is 3

GATE 21/22

$$T.F = \frac{(s+1)(s+3)}{(s^2+12s+35)(s+9)}$$

$$= \frac{(s+1)(s+3)}{3s^{10} + 9s^5 + 7s^4 + s^3 + 21s^2 + 143s + 315}$$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -315 & -143 & -215 \end{bmatrix}_{3 \times 3}$$

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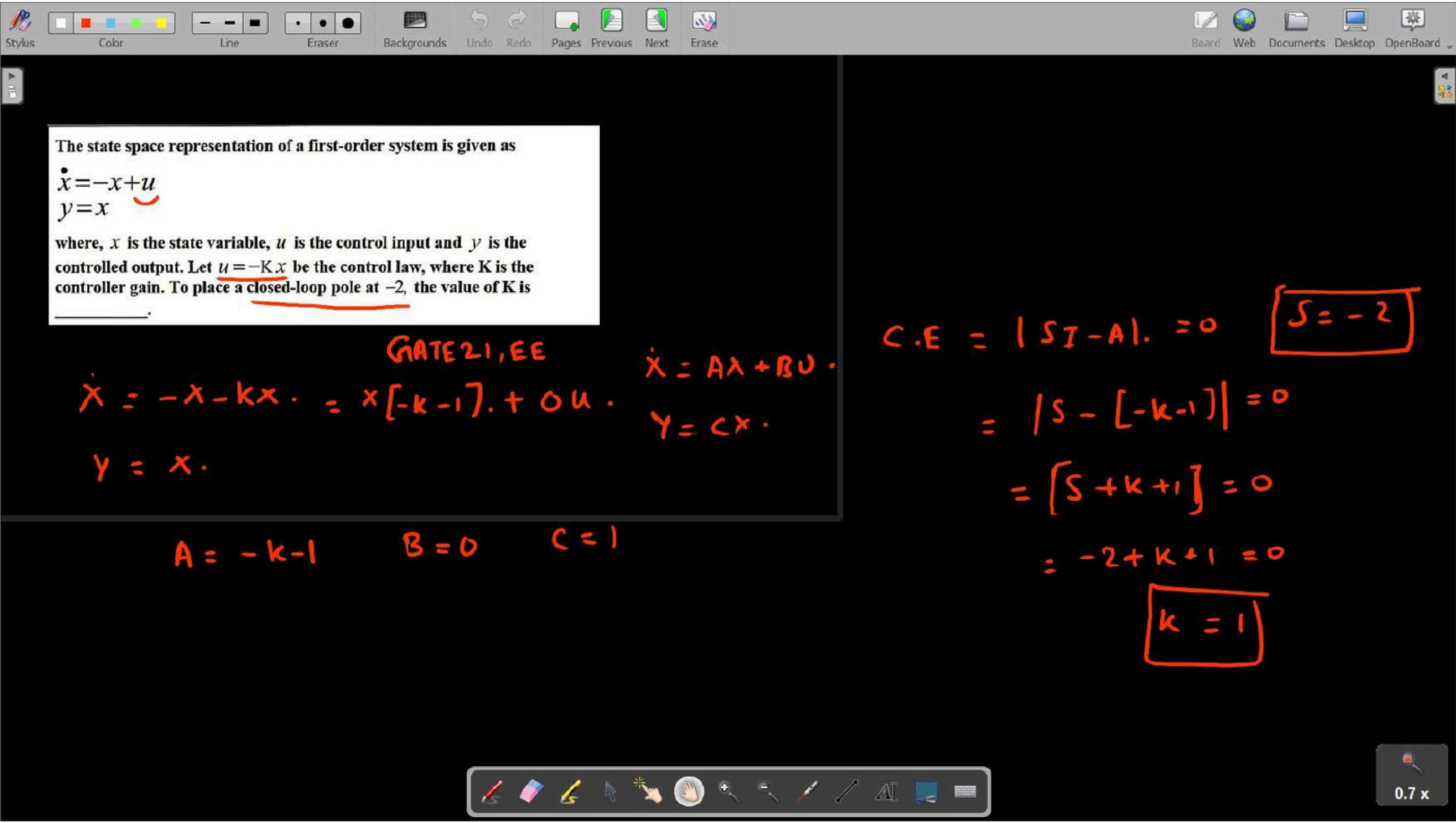

The state space representation of a first-order system is given as

$$\dot{x} = -x + \underbrace{u}$$

$$y = x$$

where, x is the state variable, u is the control input and y is the controlled output. Let $u = -Kx$ be the control law, where K is the controller gain. To place a closed-loop pole at -2, the value of K is ________.

GATE21, EE

$$\dot{x} = -x - kx. = x[-k-1]. + 0u.$$

$$y = x.$$

$$\dot{x} = Ax + Bu.$$

$$Y = Cx.$$

$$A = -k-1 \qquad B = 0 \qquad C = 1$$

$$C.E = |sI - A|. = 0 \qquad \boxed{s = -2}$$

$$= |s - [-k-1]| = 0$$

$$= [s + k + 1] = 0$$

$$= -2 + k + 1 = 0$$

$$\boxed{k = 1}$$

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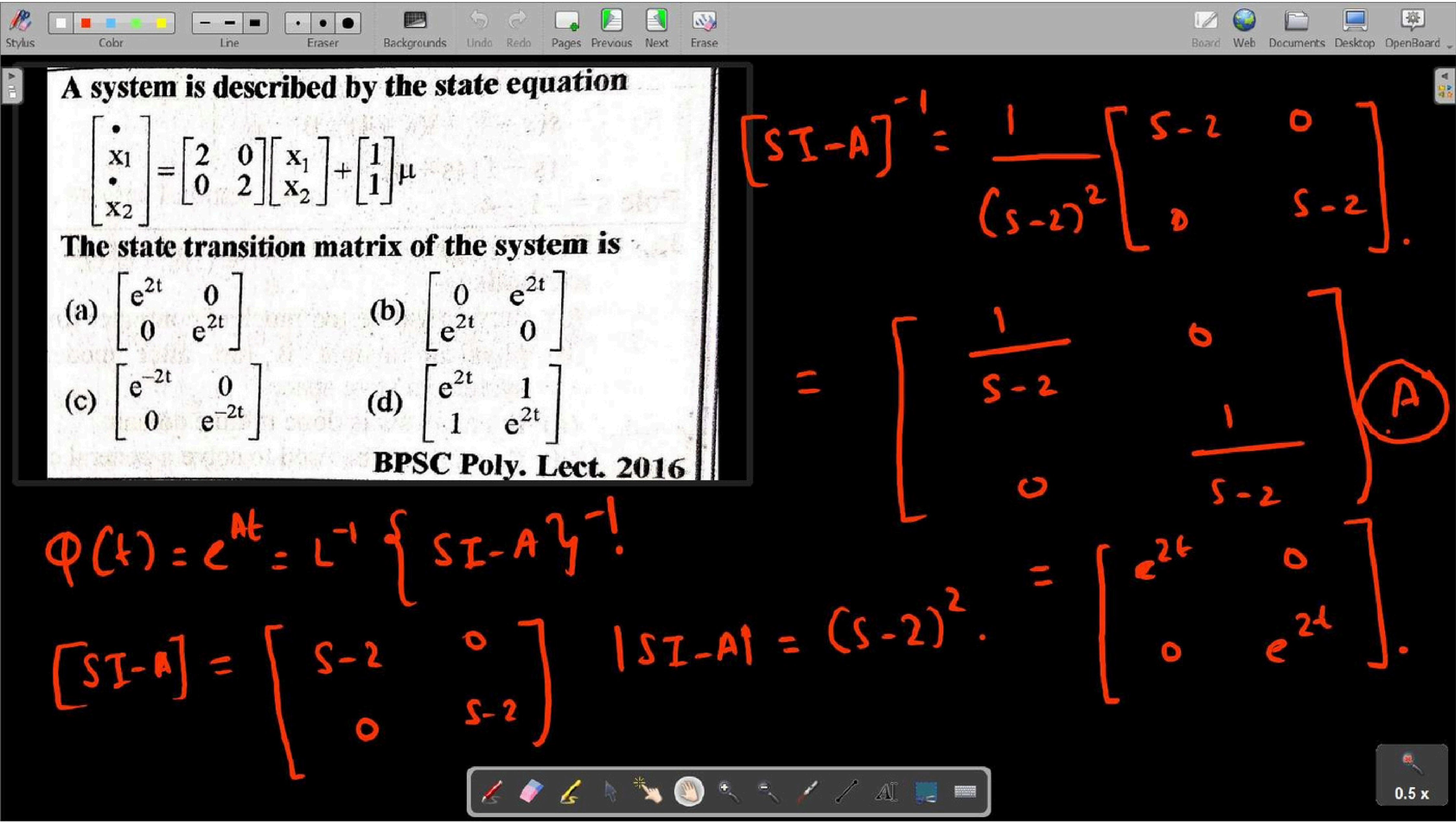


A system is described by the state equation

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}2 & 0\\ 0 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 1\end{bmatrix}\mu$$

The state transition matrix of the system is

(a) $\begin{bmatrix}e^{2t} & 0\\ 0 & e^{2t}\end{bmatrix}$ (b) $\begin{bmatrix}0 & e^{2t}\\ e^{2t} & 0\end{bmatrix}$

(c) $\begin{bmatrix}e^{-2t} & 0\\ 0 & e^{-2t}\end{bmatrix}$ (d) $\begin{bmatrix}e^{2t} & 1\\ 1 & e^{2t}\end{bmatrix}$

BPSC Poly. Lect. 2016

$$[SI-A]^{-1} = \frac{1}{(s-2)^2}\begin{bmatrix}s-2 & 0\\ 0 & s-2\end{bmatrix}.$$

$$= \begin{bmatrix}\frac{1}{s-2} & 0\\ 0 & \frac{1}{s-2}\end{bmatrix} \quad Ⓐ$$

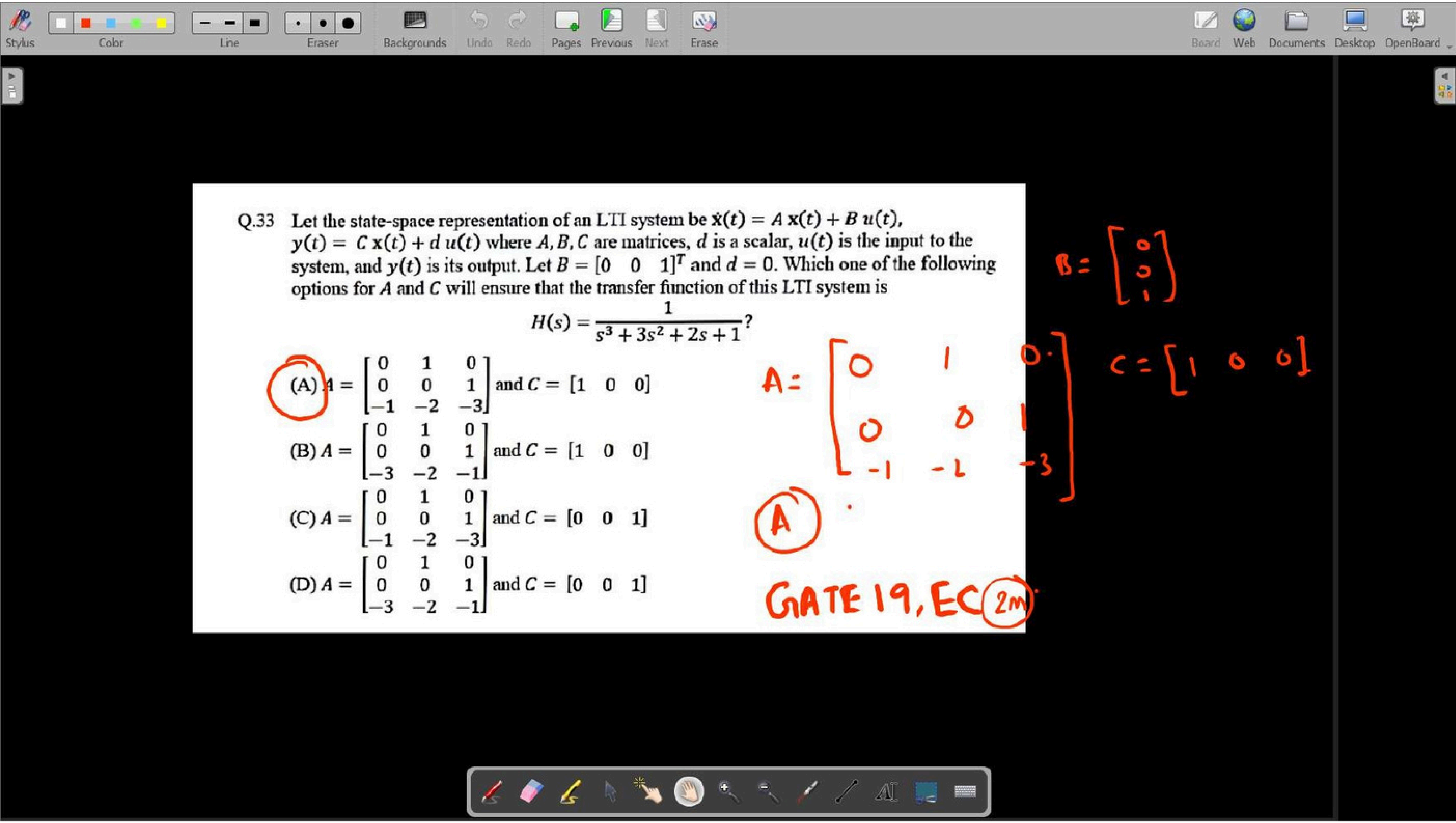
$$\phi(t) = e^{At} = L^{-1}\{SI-A\}^{-1}$$

$$= \begin{bmatrix}e^{2t} & 0\\ 0 & e^{2t}\end{bmatrix}.$$

$$[SI-A] = \begin{bmatrix}s-2 & 0\\ 0 & s-2\end{bmatrix}$$

$$|SI-A| = (s-2)^2.$$

Full Video Link



Q.33 Let the state-space representation of an LTI system be $\dot{\mathrm{x}}(t) = A\,\mathrm{x}(t) + B\,u(t)$, $y(t) = C\,\mathrm{x}(t) + d\,u(t)$ where A, B, C are matrices, d is a scalar, $u(t)$ is the input to the system, and $y(t)$ is its output. Let $B = [0 \quad 0 \quad 1]^T$ and $d = 0$. Which one of the following options for A and C will ensure that the transfer function of this LTI system is

$$H(s) = \frac{1}{s^3 + 3s^2 + 2s + 1}?$$

[✓ (A)] $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix}$ and $C = [1 \quad 0 \quad 0]$

(B) $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -1 \end{bmatrix}$ and $C = [1 \quad 0 \quad 0]$

(C) $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix}$ and $C = [0 \quad 0 \quad 1]$

(D) $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -3 & -2 & -1 \end{bmatrix}$ and $C = [0 \quad 0 \quad 1]$

$B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix}$

$C = [1 \quad 0 \quad 0]$

Ⓐ

GATE 19, EC (2M)

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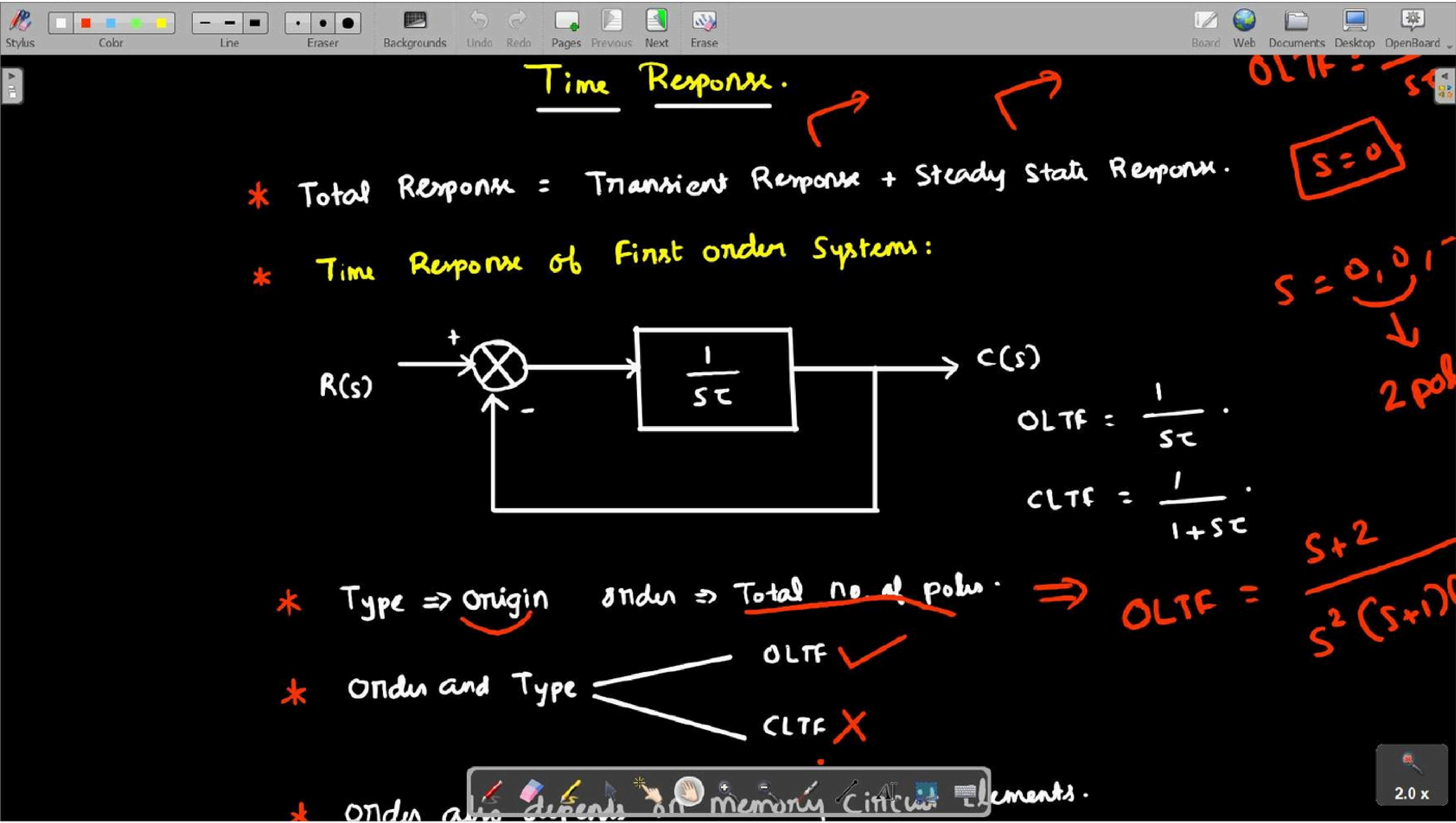


Time Response.

OLTF =

$\boxed{s=0}$

* Total Response = Transient Response + Steady State Response.

* Time Response of First order Systems:

OLTF = $\frac{1}{s\tau}$.

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

$s = 0, 0, -1$

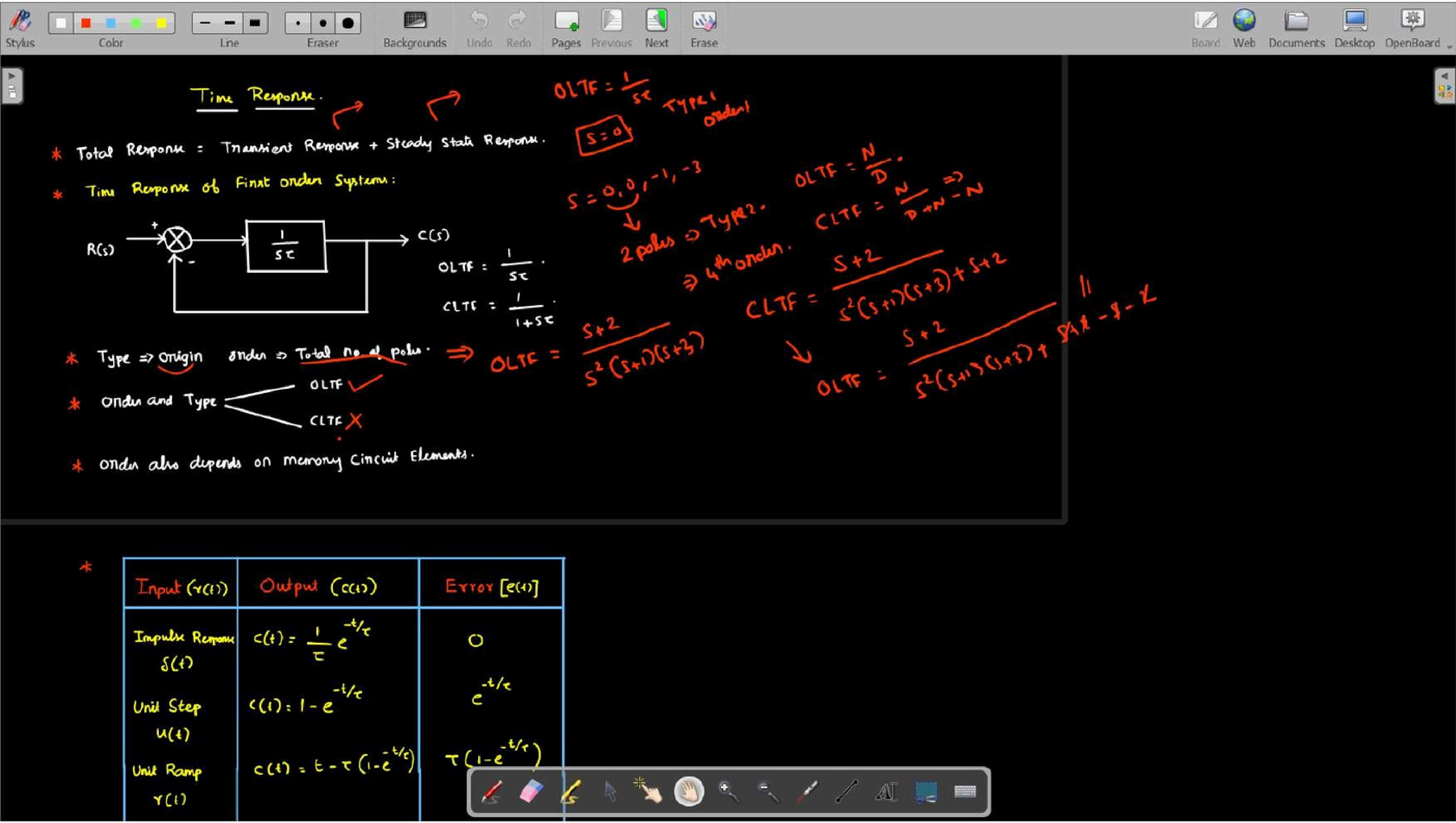
2 pol

* Type ⇒ Origin order ⇒ Total no. of poles. ⇒ OLTF = $\frac{s+2}{s^2(s+1)}$

* Order and Type
  - OLTF ✓
  - CLTF ✗

* Order also depends on memory circuit elements.

Full Video Link



Time Response.

- * Total Response = Transient Response + Steady State Response.
- * Time Response of First order Systems:

$OLTF = \frac{1}{s\tau}$.

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

- * Type ⇒ origin order ⇒ Total no of poles. ⇒ $OLTF = \frac{s+2}{s^2(s+1)(s+3)}$
- * order and Type — OLTF ✓ — CLTF ✗
- * order also depends on memory Circuit Elements.

$OLTF = \frac{1}{s\tau}$ Type 1 order 1

$\boxed{s=0}$

$s = \underbrace{0, 0}, -1, -3$

↓

2 poles ⇒ Type 2.

⇒ 4th order.

$OLTF = \frac{N}{D}$.

$CLTF = \frac{N}{D+N} \Rightarrow -N$

$CLTF = \frac{s+2}{s^2(s+1)(s+3)+s+2}$

↓

$OLTF = \frac{s+2}{s^2(s+1)(s+3)+\cancel{s}+\cancel{2}-\cancel{s}-2}$ ||

*

Input (r(t))	Output (c(t))	Error [e(t)]
Impulse Response $\delta(t)$	$c(t) = \frac{1}{\tau}e^{-t/\tau}$	0
Unit Step $u(t)$	$c(t) = 1 - e^{-t/\tau}$	$e^{-t/\tau}$
Unit Ramp $r(t)$	$c(t) = t - \tau(1-e^{-t/\tau})$	$\tau(1-e^{-t/\tau})$

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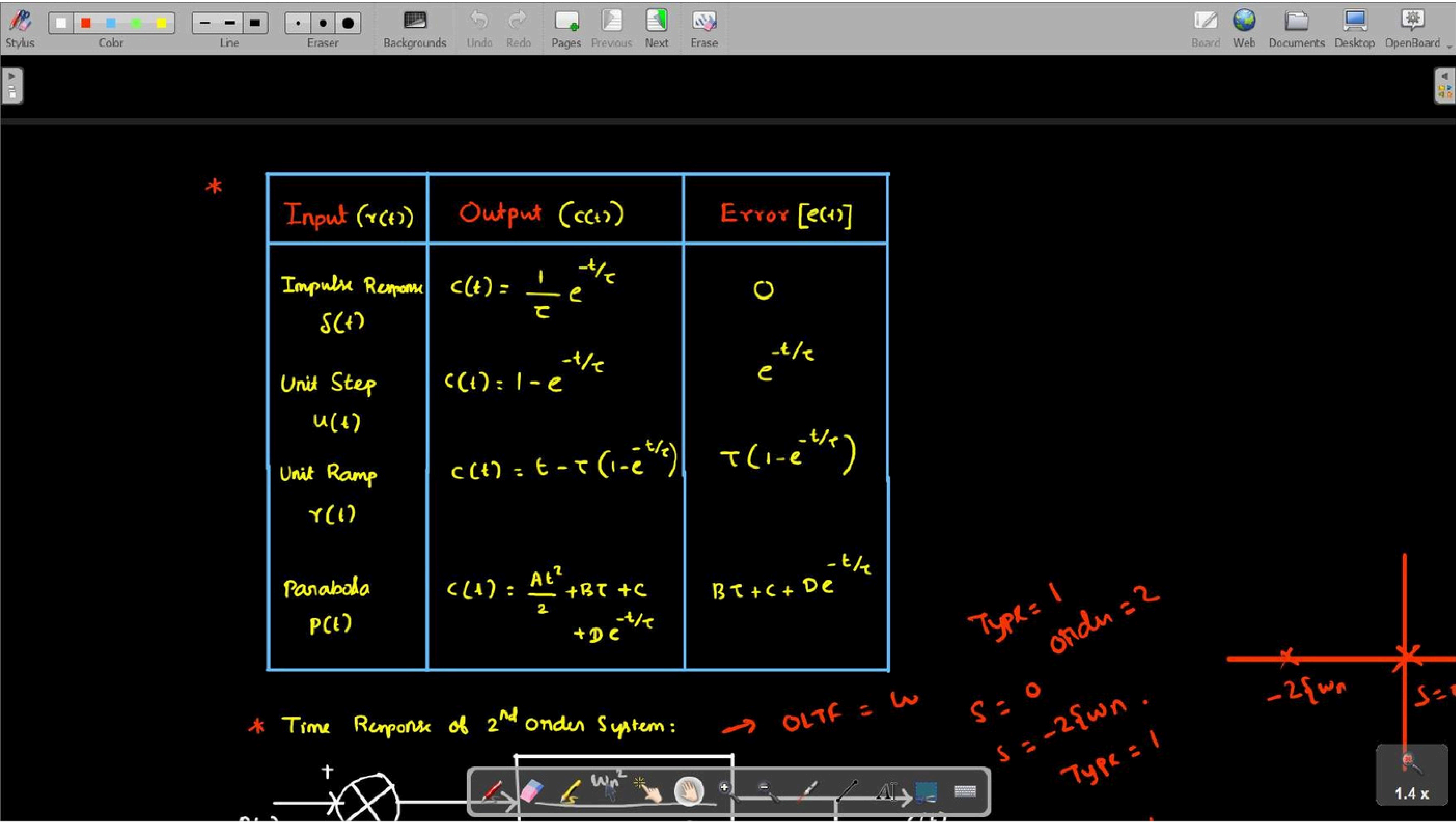


*

Input $(r(t))$	Output $(c(t))$	Error $[e(t)]$
Impulse Response $\delta(t)$	$c(t) = \frac{1}{\tau} e^{-t/\tau}$	0
Unit Step $u(t)$	$c(t) = 1 - e^{-t/\tau}$	$e^{-t/\tau}$
Unit Ramp $r(t)$	$c(t) = t - \tau(1 - e^{-t/\tau})$	$\tau(1 - e^{-t/\tau})$
Parabola $P(t)$	$c(t) = \frac{At^2}{2} + B\tau + C + De^{-t/\tau}$	$B\tau + C + De^{-t/\tau}$

* Time Response of 2nd order System :

→ OLTF = ω

Type = 1

order = 2

$s = 0$

$s = -2\xi\omega_n$.

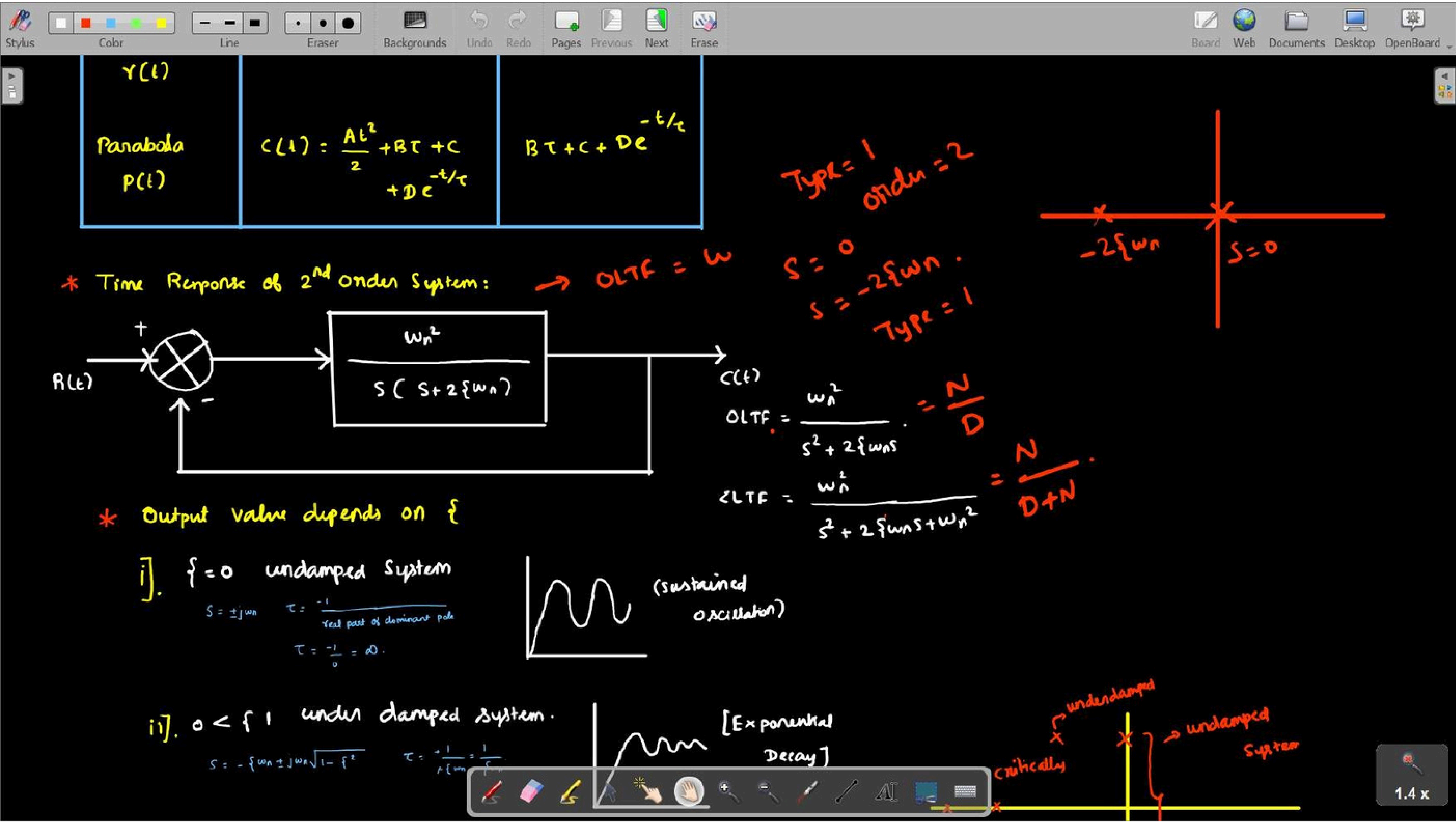
Type = 1

$-2\xi\omega_n$

$s =$

$+$

Full Video Link



Y(t)		
Parabola P(t)	$c(t) = \frac{At^2}{2} + B\tau + C + De^{-t/\tau}$	$B\tau + C + De^{-t/\tau}$

* Time Response of 2^{nd} order System: → OLTF = ω

Type = 1
order = 2

$s = 0$
$s = -2\zeta\omega_n$.
Type = 1

$$OLTF = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s} = \frac{N}{D}$$

$$CLTF = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2} = \frac{N}{D+N}.$$

* Output value depends on ζ

i]. $\zeta = 0$ undamped System

$s = \pm j\omega_n$ $\tau = \frac{-1}{\text{real part of dominant pole}}$

$\tau = \frac{-1}{0} = \infty$.

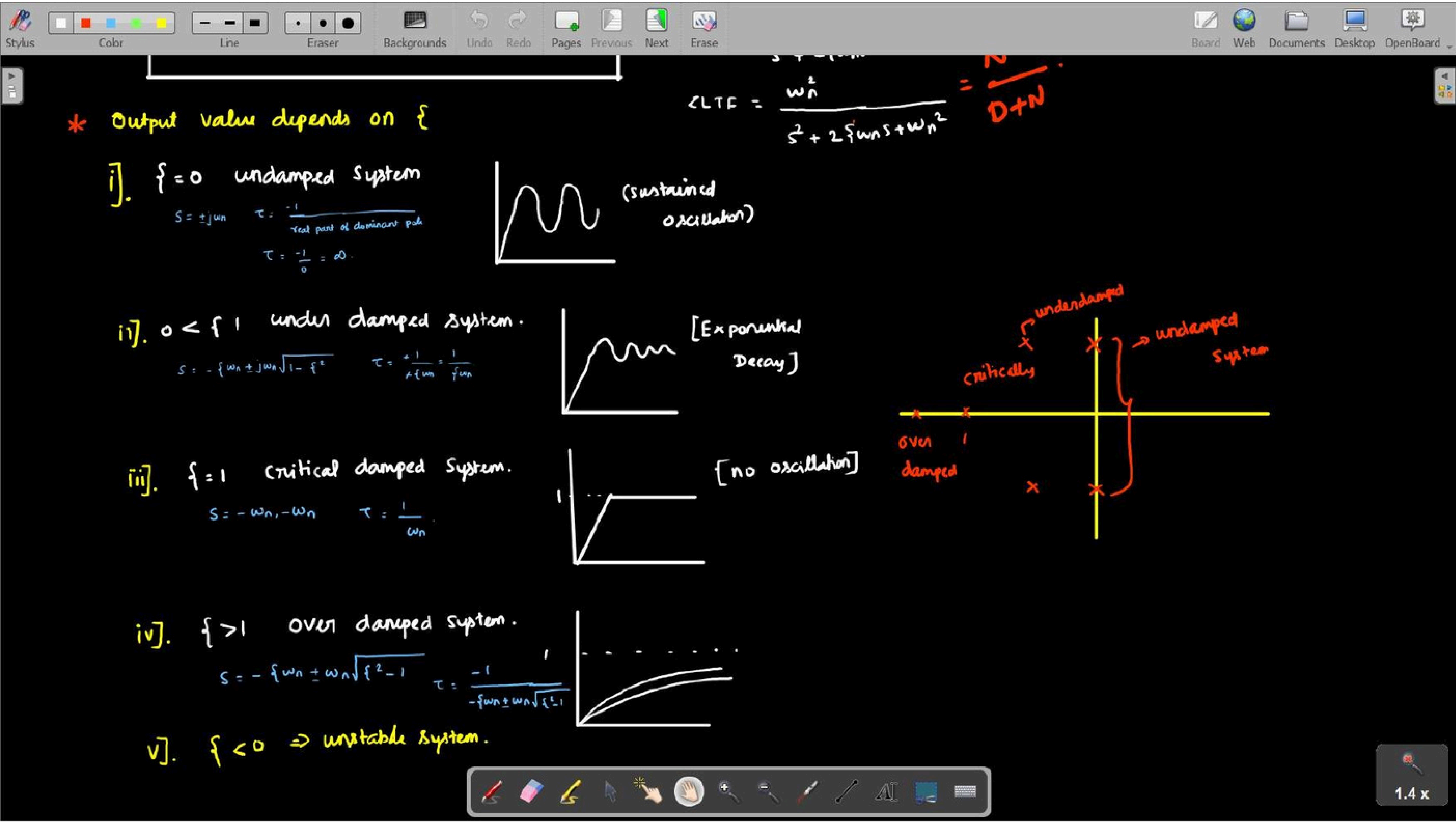
(sustained oscillation)

ii]. $0 < \zeta 1$ under damped system.

$s = -\zeta\omega_n \pm j\omega_n\sqrt{1-\zeta^2}$ $\tau = \frac{+1}{+\zeta\omega_n} = \frac{1}{\zeta}$

[Exponential Decay]

Full Video Link



$CLTF = \frac{w_n^2}{s^2 + 2\xi w_n s + w_n^2} = \frac{N}{D+N}$.

* Output value depends on ξ

i]. $\xi = 0$ undamped System

$s = \pm j\omega_n$ $\tau = \frac{-1}{\text{real part of dominant pole}}$

$\tau = \frac{-1}{0} = \infty$.

(sustained oscillation)

ii]. $0 < \xi 1$ under damped system.

$s = -\xi\omega_n \pm j\omega_n\sqrt{1-\xi^2}$ $\tau = \frac{+1}{+\xi\omega_n} = \frac{1}{\xi\omega_n}$

[Exponential Decay]

iii]. $\xi = 1$ critical damped System.

$s = -\omega_n, -\omega_n$ $\tau = \frac{1}{\omega_n}$.

1

[no oscillation]

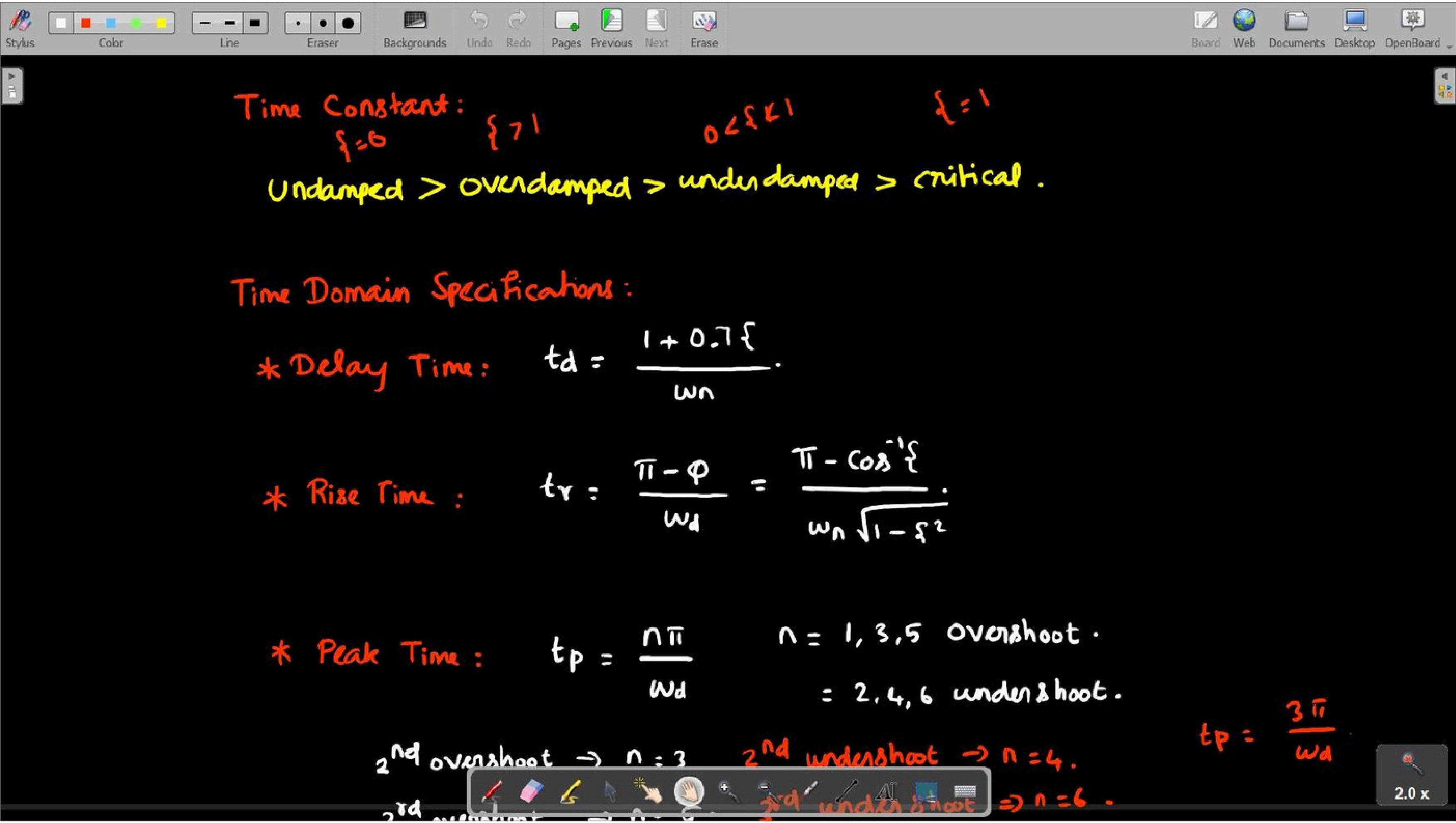
iv]. $\xi > 1$ over damped system.

$s = -\xi\omega_n \pm \omega_n\sqrt{\xi^2 - 1}$ $\tau = \frac{-1}{-\xi\omega_n \pm \omega_n\sqrt{\xi^2-1}}$

1

v]. $\xi < 0 \Rightarrow$ unstable system.

Full Video Link



Time Constant:

$\xi = 0$ $\xi > 1$ $0 < \xi < 1$ $\xi = 1$

Undamped > overdamped > underdamped > critical.

Time Domain Specifications:

* Delay Time: $t_d = \dfrac{1 + 0.7\xi}{\omega_n}$.

* Rise Time : $t_r = \dfrac{\pi - \phi}{\omega_d} = \dfrac{\pi - \cos^{-1}\xi}{\omega_n\sqrt{1-\xi^2}}$.

* Peak Time : $t_p = \dfrac{n\pi}{\omega_d}$ $n = 1, 3, 5$ overshoot.

$= 2, 4, 6$ undershoot.

$t_p = \dfrac{3\pi}{\omega_d}$

2^{nd} overshoot → $n = 3$ 2^{nd} undershoot → $n = 4$.

3^{rd} overshoot 3^{rd} undershoot ⇒ $n = 6$.

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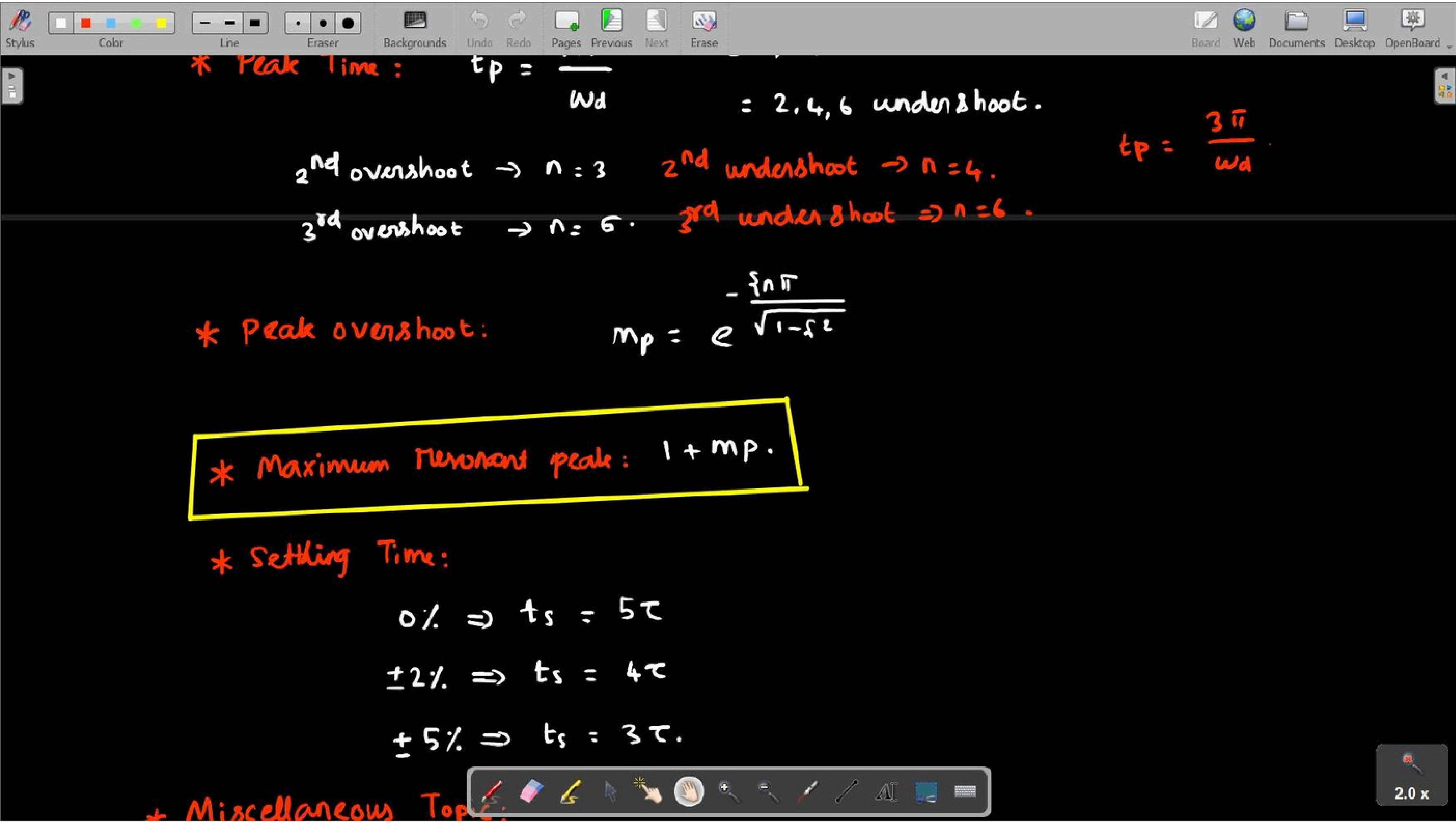


* Peak Time : $t_p = \frac{\quad}{W_d}$

= 2, 4, 6 undershoot.

$t_p = \frac{3\pi}{\omega_d}$

2^{nd} overshoot → $n = 3$ 2^{nd} undershoot → $n = 4$.

3^{rd} overshoot → $n = 5$. 3^{rd} undershoot ⇒ $n = 6$.

* Peak overshoot: $M_p = e^{-\frac{\xi n \pi}{\sqrt{1-\xi^2}}}$

$\boxed{\text{* Maximum resonant peak : } 1 + m_p.}$

* Settling Time:

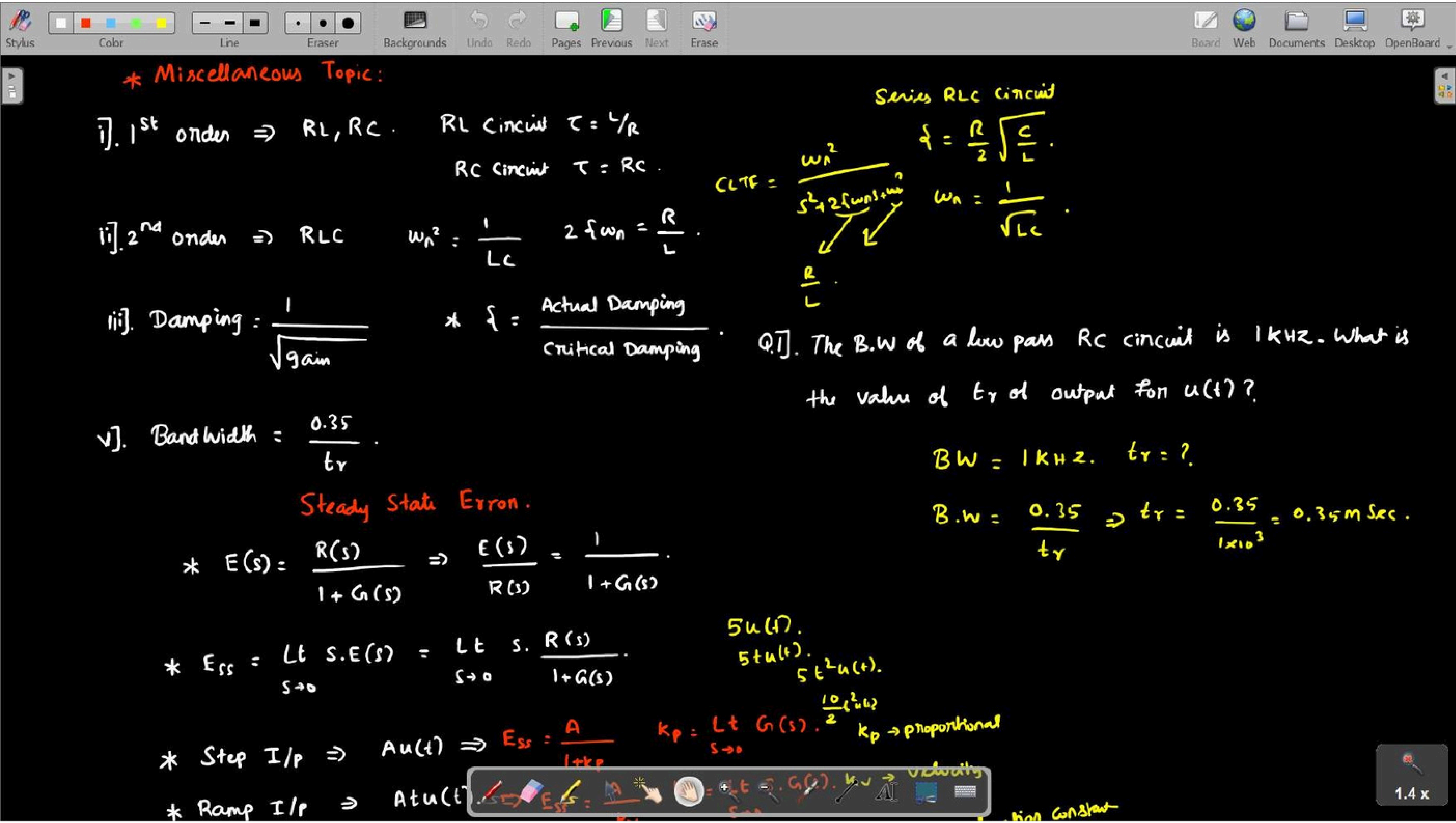
$0\% \Rightarrow t_s = 5\tau$

$\pm 2\% \Rightarrow t_s = 4\tau$

$\pm 5\% \Rightarrow t_s = 3\tau$.

* Miscellaneous Topic:

Full Video Link



* Miscellaneous Topic:

i]. 1st order ⇒ RL, RC.

RL Circuit $\tau = L/R$

RC Circuit $\tau = RC$.

ii]. 2nd order ⇒ RLC $\quad \omega_n^2 = \frac{1}{LC} \quad 2\zeta\omega_n = \frac{R}{L}$.

iii]. Damping : $\frac{1}{\sqrt{gain}}$ $\qquad$ * $\zeta = \frac{\text{Actual Damping}}{\text{Critical Damping}}$.

v]. Band width $= \frac{0.35}{t_r}$.

Series RLC Circuit

$$\zeta = \frac{R}{2}\sqrt{\frac{C}{L}}.$$

$$CLTF = \frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$$

$$\frac{R}{L}.$$

$$\omega_n = \frac{1}{\sqrt{LC}}.$$

Q1]. The B.W of a low pass RC circuit is 1KHz. What is the value of t_r of output for u(t)?

BW = 1KHz. $t_r = ?$

$$B.W = \frac{0.35}{t_r} \Rightarrow t_r = \frac{0.35}{1\times10^3} = 0.35\,m\,Sec.$$

Steady State Error.

$$* \; E(s) = \frac{R(s)}{1+G(s)} \Rightarrow \frac{E(s)}{R(s)} = \frac{1}{1+G(s)}.$$

$$* \; E_{ss} = \underset{s\to0}{Lt}\, s.E(s) = \underset{s\to0}{Lt}\, s.\frac{R(s)}{1+G(s)}.$$

5u(t).

5tu(t).

$5t^2u(t)$.

$\frac{10}{2}t^2u(t)$

* Step I/p ⇒ Au(t) ⇒ $E_{ss} = \frac{A}{1+k_p}$ $\qquad k_p = \underset{s\to0}{Lt}\, G(s).$ $\qquad k_p \rightarrow$ proportional

* Ramp I/p ⇒ Atu(t) $\qquad E_{ss} = \frac{A}{\;} \qquad = \underset{s\to0}{Lt}\, s.G(s). \qquad k_v \rightarrow$ velocity

tion constant

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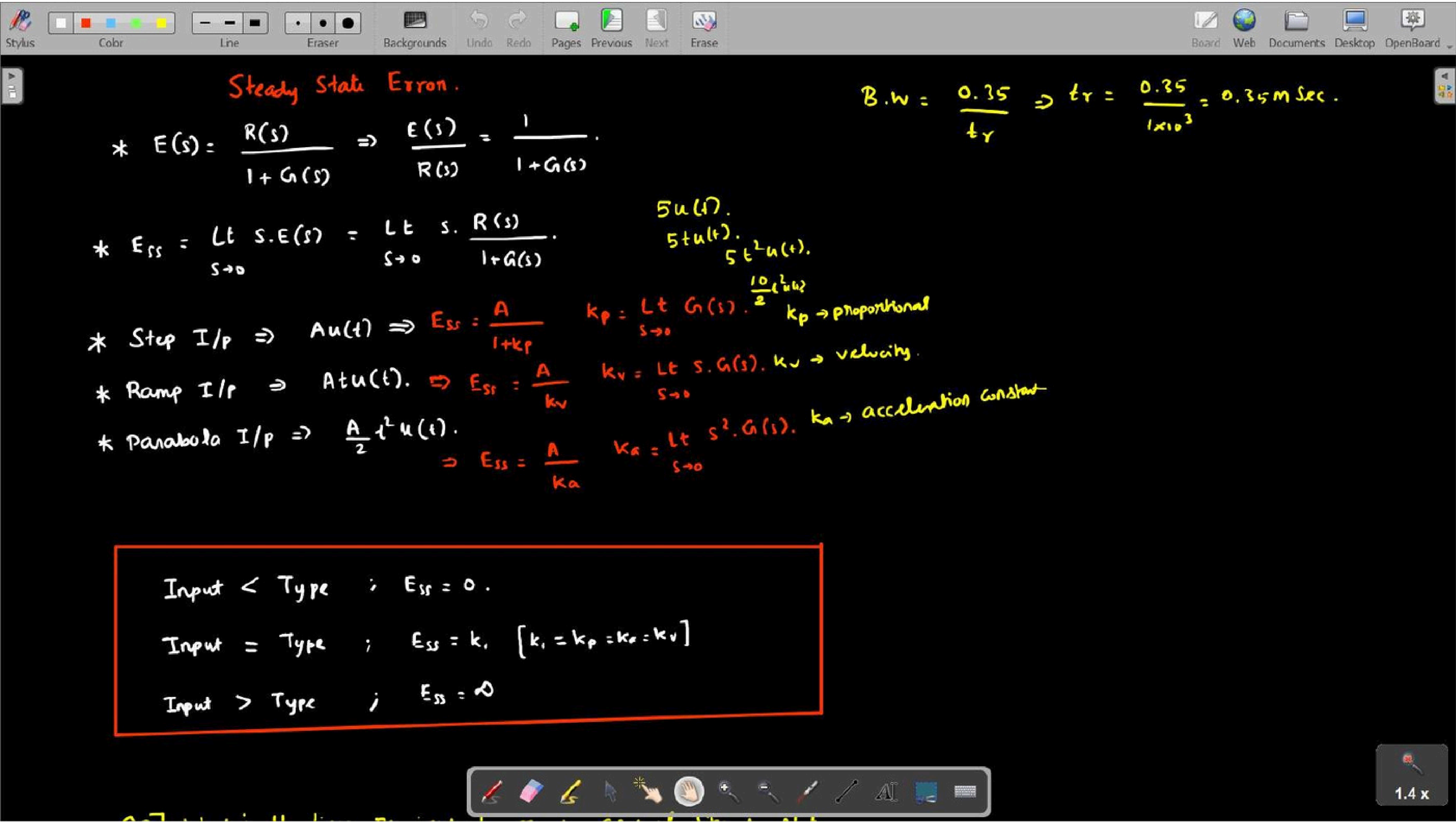


Steady State Error.

$B.W = \frac{0.35}{t_r} \Rightarrow t_r = \frac{0.35}{1\times10^3} = 0.35 \text{ m Sec.}$

- $E(s) = \frac{R(s)}{1+G(s)} \Rightarrow \frac{E(s)}{R(s)} = \frac{1}{1+G(s)}.$

- $E_{ss} = \underset{s\to 0}{Lt}\ s.E(s) = \underset{s\to 0}{Lt}\ s.\frac{R(s)}{1+G(s)}.$

$5u(t).$

$5tu(t).$

$5t^2u(t).$

$\frac{10}{2}t^2u(t)$

- Step I/p $\Rightarrow Au(t) \Rightarrow E_{ss} = \frac{A}{1+k_p}$ $\quad k_p = \underset{s\to 0}{Lt}\ G(s).$ $\quad k_p \rightarrow$ proportional
- Ramp I/p $\Rightarrow Atu(t). \Rightarrow E_{ss} = \frac{A}{k_v}$ $\quad k_v = \underset{s\to 0}{Lt}\ s.G(s).$ $\quad k_v \rightarrow$ velocity.
- Parabola I/p $\Rightarrow \frac{A}{2}t^2u(t).$ $\quad k_a = \underset{s\to 0}{Lt}\ s^2.G(s).$ $\quad k_a \rightarrow$ acceleration constant

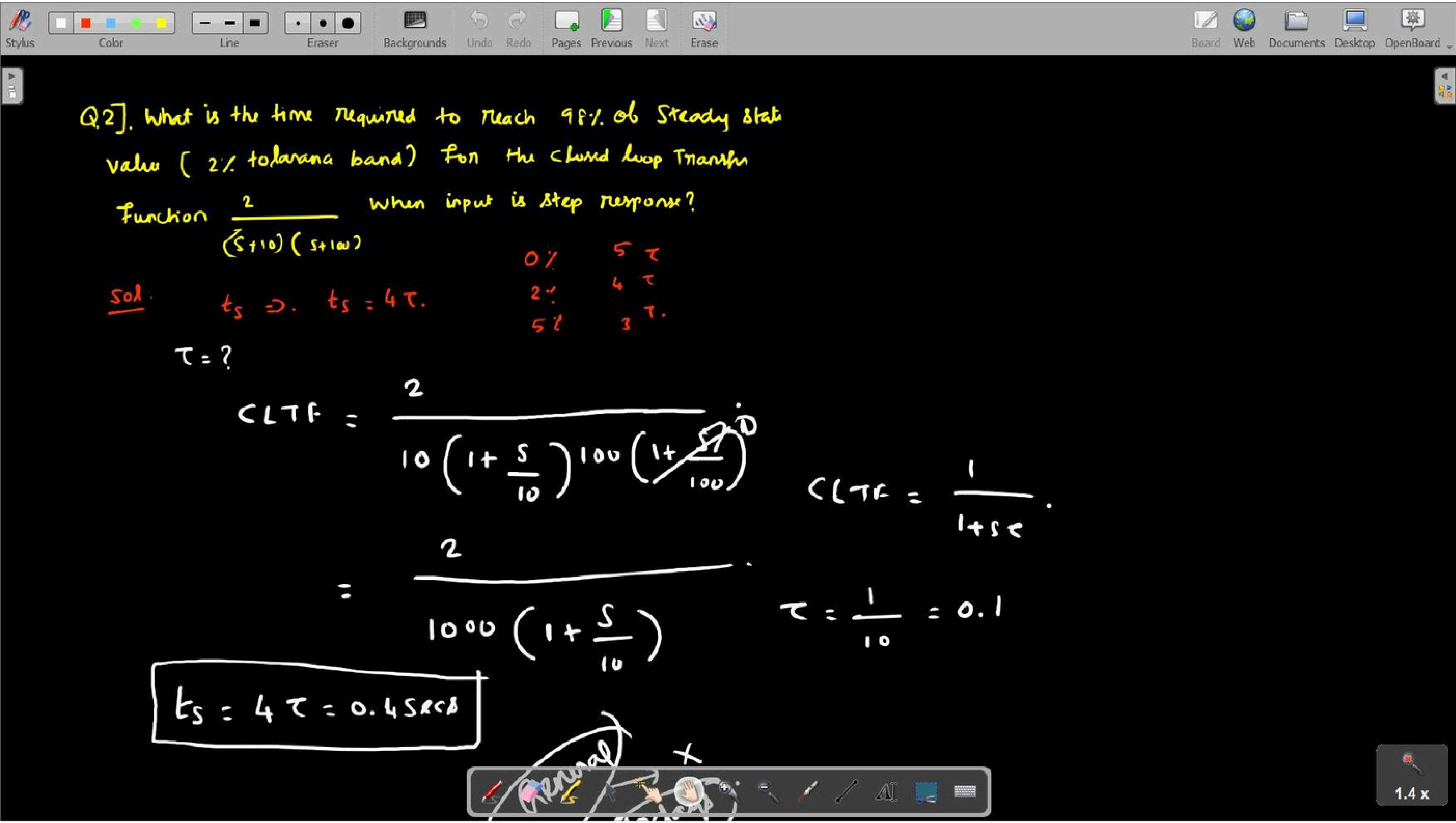
$\Rightarrow E_{ss} = \frac{A}{k_a}$

Input < Type ; $E_{ss} = 0.$

Input = Type ; $E_{ss} = k_1$ $[k_1 = k_p : k_a : k_v]$

Input > Type ; $E_{ss} = \infty$

Full Video Link



Q2]. What is the time required to reach 98% of Steady state value (2% tolarance band) for the closed loop Transfer function $\frac{2}{(s+10)(s+100)}$ when input is step response?

0%	5τ
2%	4τ
5%	3τ.

Sol. $t_s \Rightarrow. \quad t_s = 4\tau.$

$\tau = ?$

$$CLTF = \frac{2}{10\left(1+\frac{s}{10}\right)100\left(1+\cancel{\frac{s}{100}}\right)} \quad 0$$

$$= \frac{2}{1000\left(1+\frac{s}{10}\right)}.$$

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

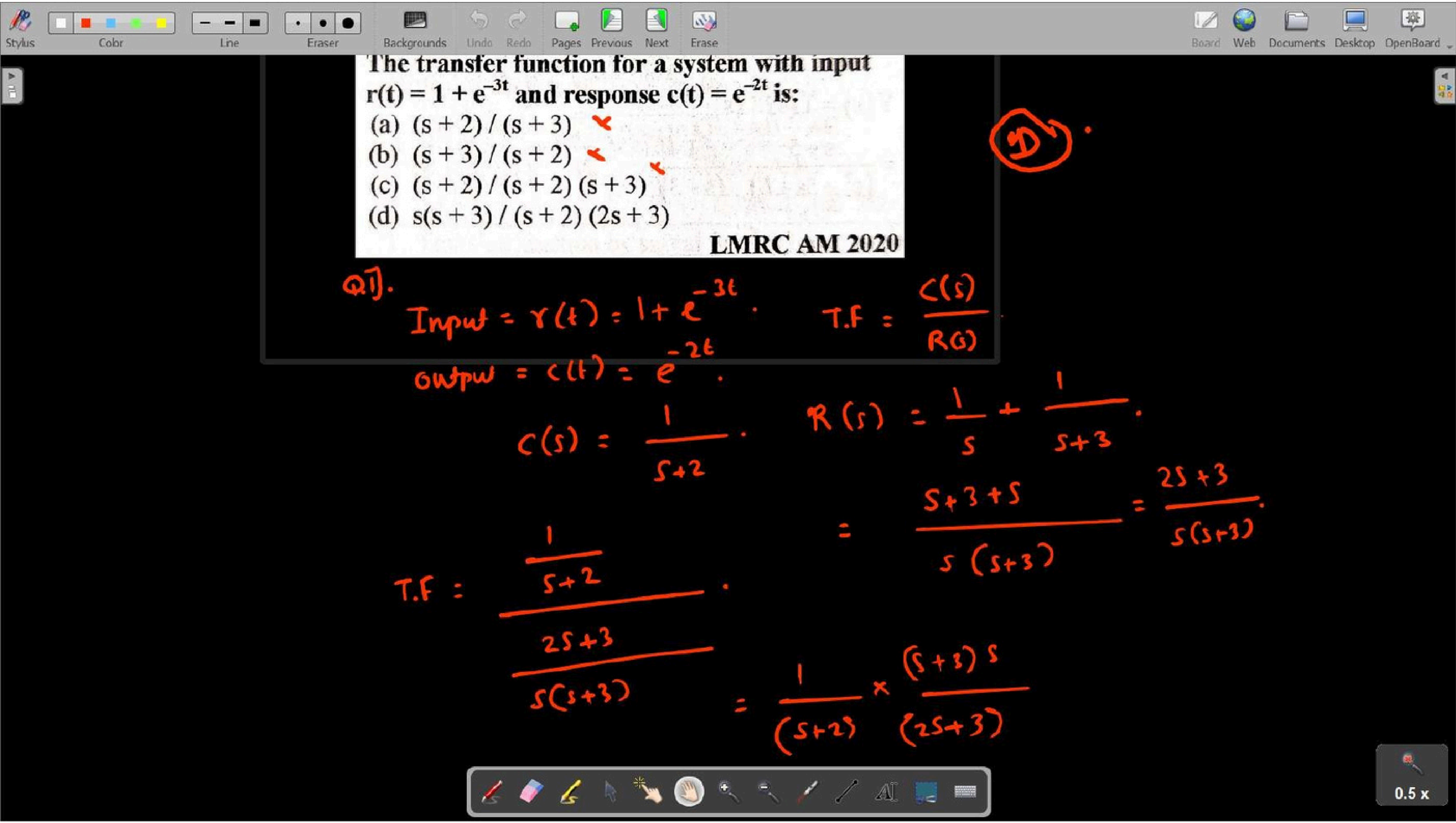
$$\tau = \frac{1}{10} = 0.1$$

$$\boxed{t_s = 4\tau = 0.4 secs}$$

Normal

x

Full Video Link



The transfer function for a system with input $r(t) = 1 + e^{-3t}$ and response $c(t) = e^{-2t}$ is:

(a) $(s + 2) / (s + 3)$

(b) $(s + 3) / (s + 2)$

(c) $(s + 2) / (s + 2)(s + 3)$

(d) $s(s + 3) / (s + 2)(2s + 3)$

LMRC AM 2020

$\boxed{D}$.

Q1].

$$\text{Input} = r(t) = 1 + e^{-3t}. \qquad T.F = \frac{C(s)}{R(s)}.$$

$$\text{output} = c(t) = e^{-2t}.$$

$$C(s) = \frac{1}{s+2}. \qquad R(s) = \frac{1}{s} + \frac{1}{s+3}.$$

$$= \frac{s+3+s}{s(s+3)} = \frac{2s+3}{s(s+3)}.$$

$$T.F = \frac{\frac{1}{s+2}}{\frac{2s+3}{s(s+3)}}.$$

$$= \frac{1}{(s+2)} \times \frac{(s+3)s}{(2s+3)}$$

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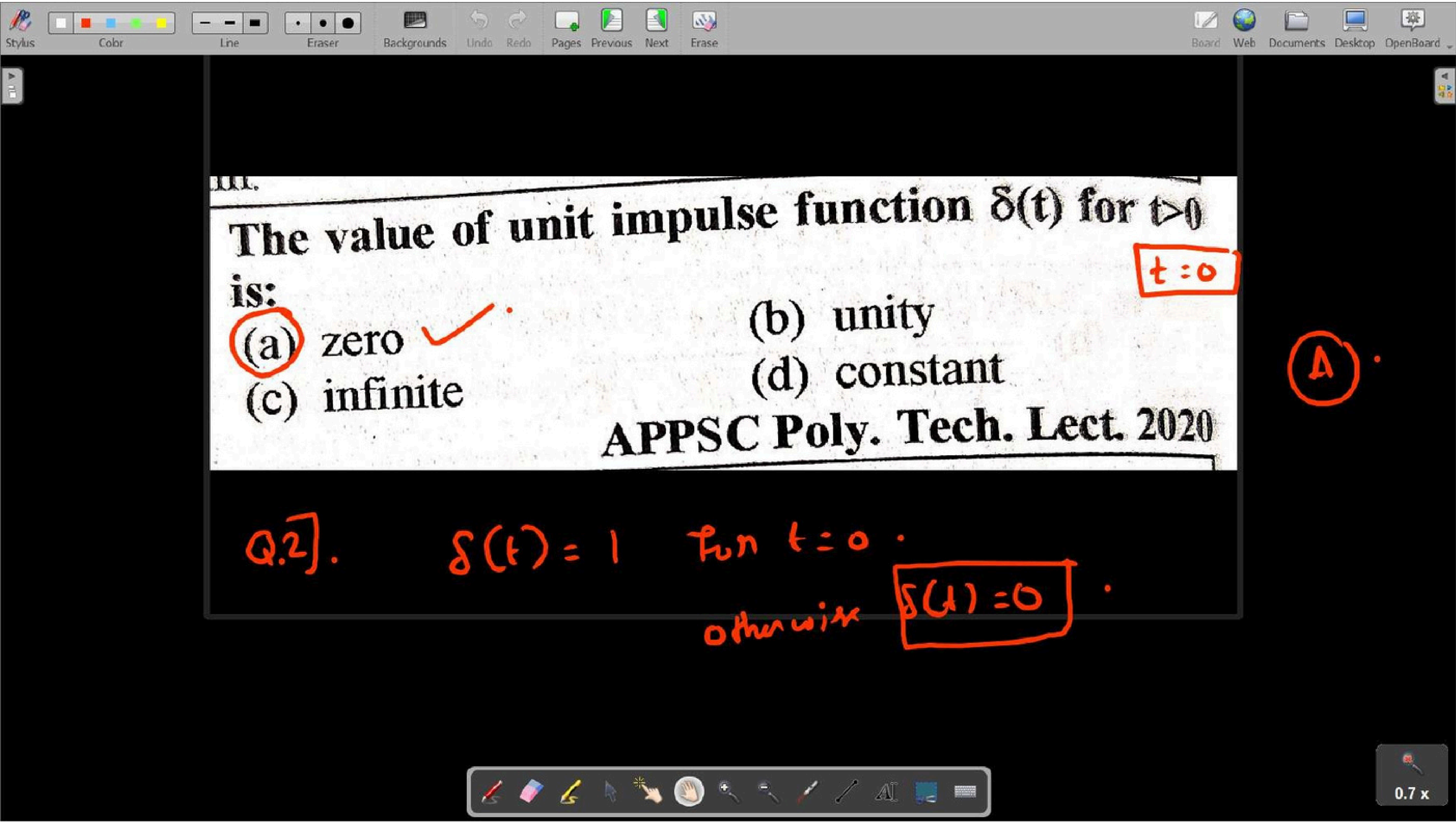


The value of unit impulse function δ(t) for t>0 is:

$t = 0$

[✓ (a) zero] ✓.

(b) unity

(c) infinite

(d) constant

APPSC Poly. Tech. Lect. 2020

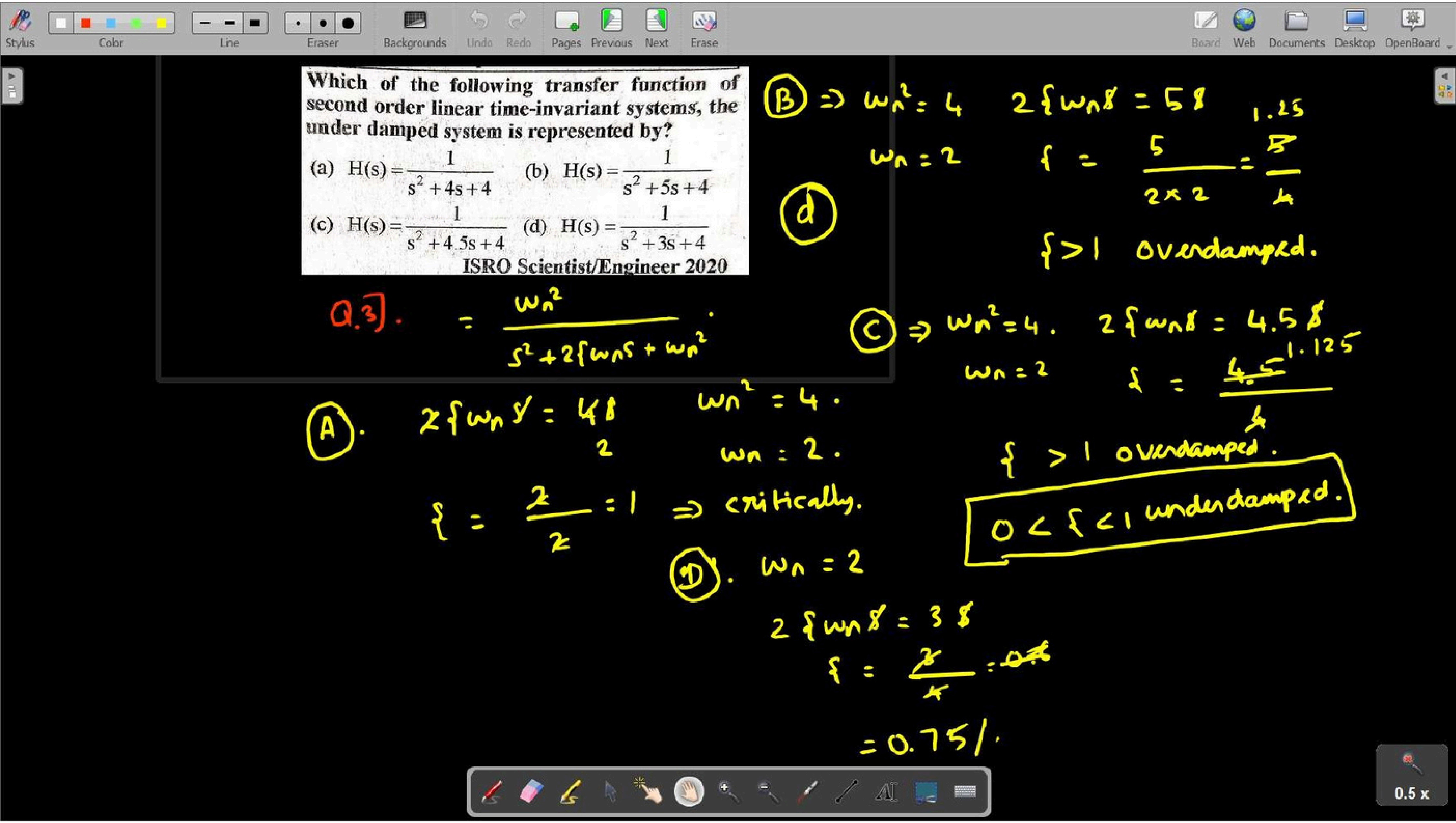
Ⓐ.

Q.2].

$\delta(t) = 1$ for $t = 0$.

otherwise $\boxed{\delta(t) = 0}$.

Full Video Link



Which of the following transfer function of second order linear time-invariant systems, the under damped system is represented by?

(a) $H(s) = \frac{1}{s^2 + 4s + 4}$ (b) $H(s) = \frac{1}{s^2 + 5s + 4}$

(c) $H(s) = \frac{1}{s^2 + 4.5s + 4}$ (d) $H(s) = \frac{1}{s^2 + 3s + 4}$

ISRO Scientist/Engineer 2020

Q.3]. $= \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$.

ⓓ

Ⓐ. $2\xi\omega_n s = \frac{4s}{2}$ $\omega_n^2 = 4.$

$\omega_n = 2.$

$\xi = \frac{2}{2} = 1 \Rightarrow$ critically.

Ⓑ $\Rightarrow \omega_n^2 = 4$ $2\xi\omega_n s = 5s$

$\omega_n = 2$ $\xi = \frac{5}{2\times 2} = \frac{5}{4}$ 1.25

$\xi > 1$ overdamped.

Ⓒ $\Rightarrow \omega_n^2 = 4.$ $2\xi\omega_n s = 4.5s$

$\omega_n = 2$ $\xi = \frac{4.5}{4}$ 1.125

$\xi > 1$ overdamped.

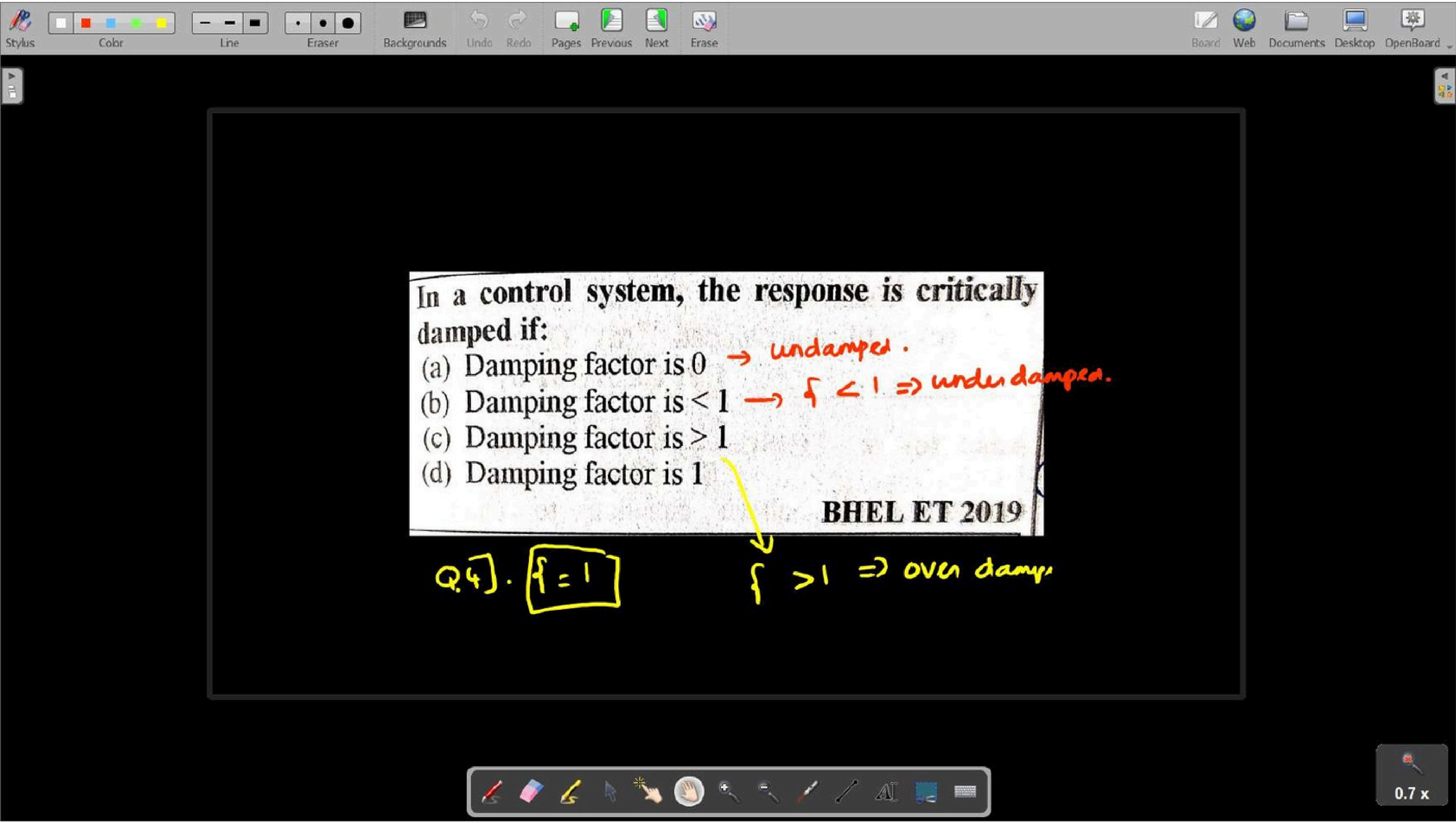
$$\boxed{0 < \xi < 1 \text{ underdamped.}}$$

Ⓓ. $\omega_n = 2$

$2\xi\omega_n s = 3s$

$\xi = \frac{3}{4}$: [illegible]

$= 0.75$/.



In a control system, the response is critically damped if:

(a) Damping factor is 0 → undamped.

(b) Damping factor is < 1 → $\xi < 1 \Rightarrow$ underdamped.

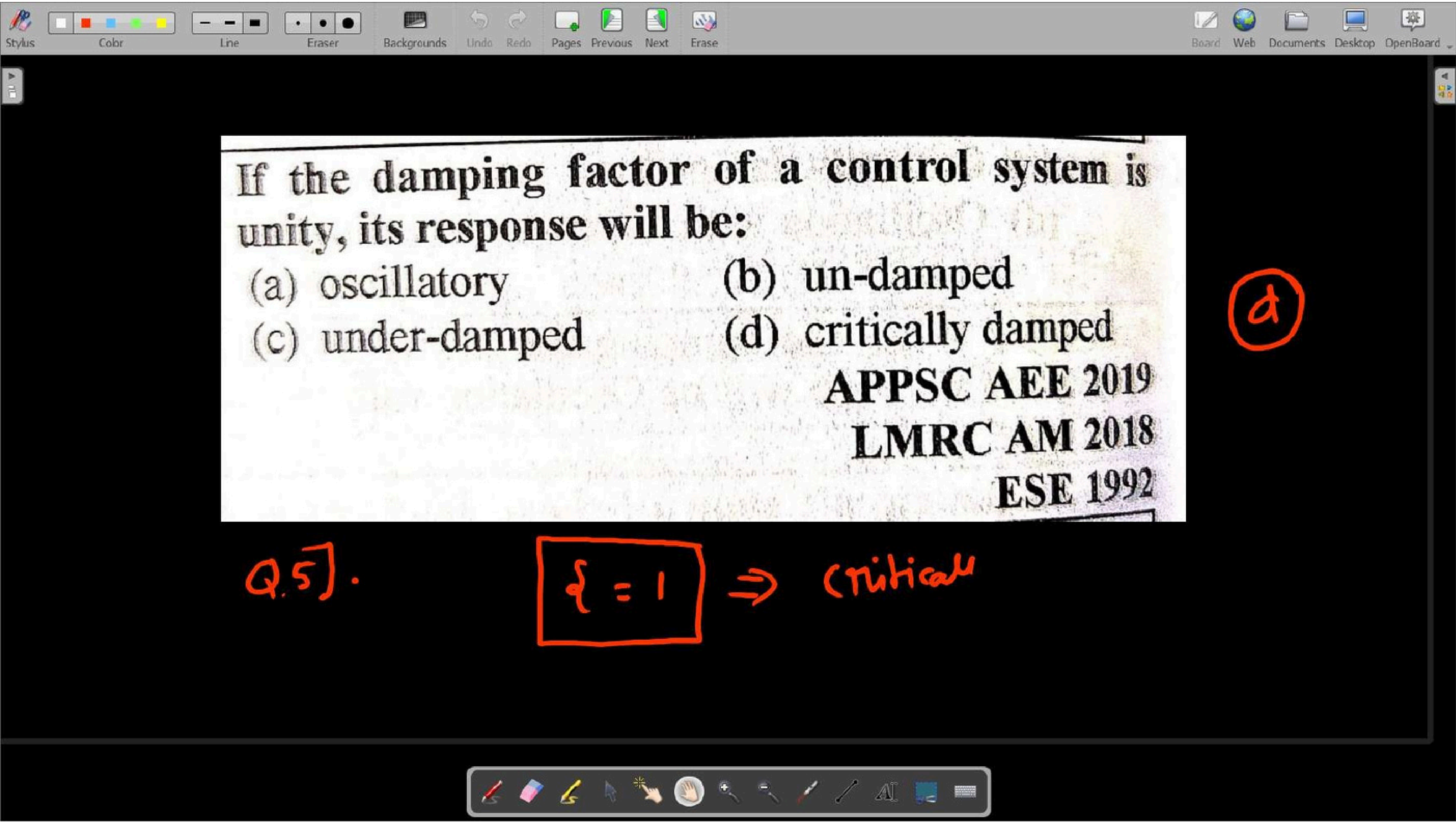
(c) Damping factor is > 1

(d) Damping factor is 1

BHEL ET 2019

Q.4]. $\boxed{\xi = 1}$

$\xi > 1 \Rightarrow$ over damp



If the damping factor of a control system is unity, its response will be:

(a) oscillatory
(b) un-damped
(c) under-damped
(d) critically damped

APPSC AEE 2019
LMRC AM 2018
ESE 1992

ⓓ

Q.5].

$\boxed{\xi = 1} \Rightarrow$ critical

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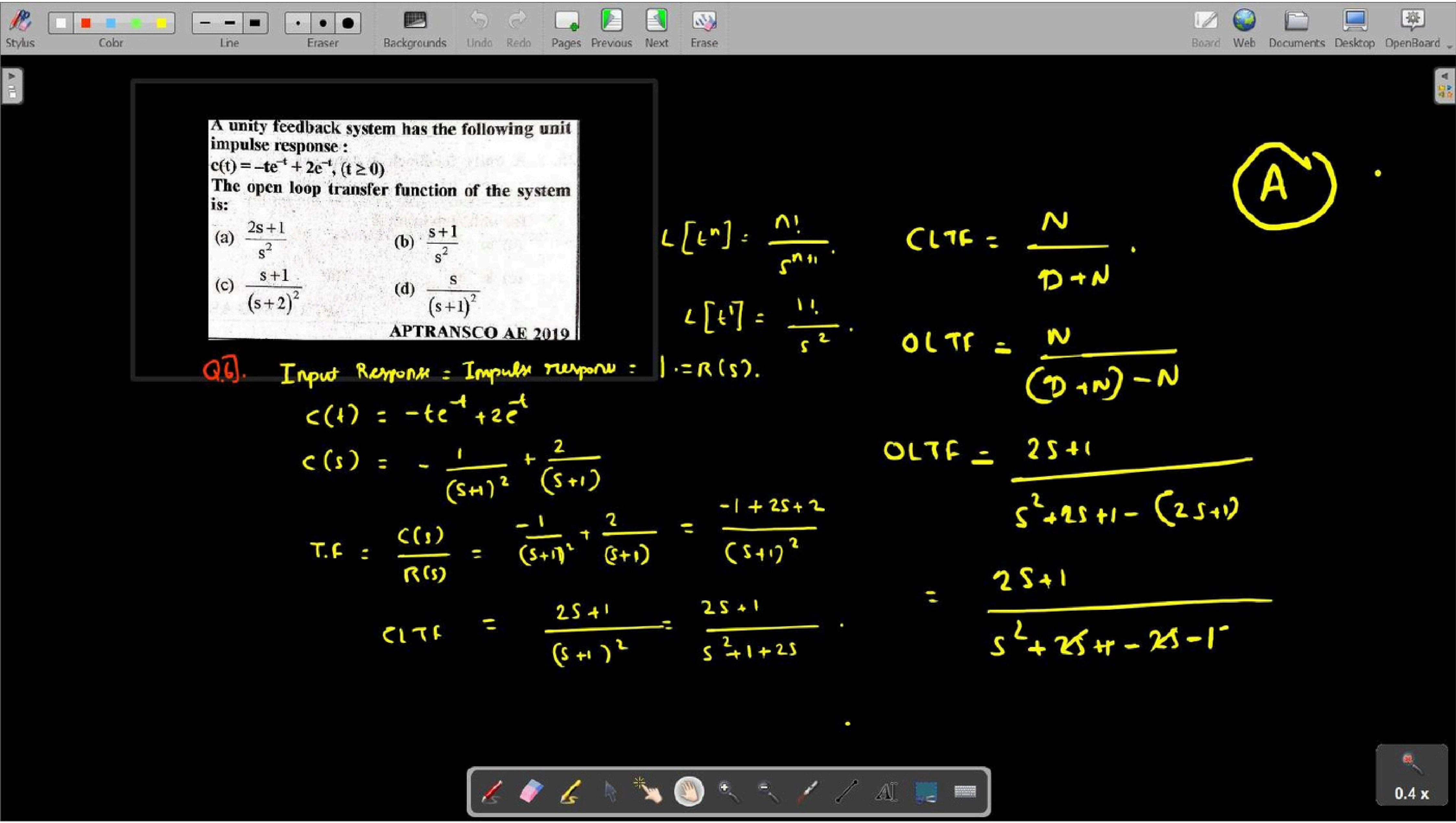


A unity feedback system has the following unit impulse response :

$c(t) = -te^{-t} + 2e^{-t}, (t \geq 0)$

The open loop transfer function of the system is:

(a) $\frac{2s+1}{s^2}$ (b) $\frac{s+1}{s^2}$

(c) $\frac{s+1}{(s+2)^2}$ (d) $\frac{s}{(s+1)^2}$

APTRANSCO AE 2019

Q.6. Input Response = Impulse response = 1 · = R(s).

$c(t) = -te^{-t} + 2e^{-t}$

$c(s) = -\frac{1}{(s+1)^2} + \frac{2}{(s+1)}$

$T.F = \frac{C(s)}{R(s)} = \frac{-1}{(s+1)^2} + \frac{2}{(s+1)} = \frac{-1+2s+2}{(s+1)^2}$

$CLTF = \frac{2s+1}{(s+1)^2} = \frac{2s+1}{s^2+1+2s}$.

$L[t^n] = \frac{n!}{s^{n+1}}$.

$L[t^1] = \frac{1!}{s^2}$.

$CLTF = \frac{N}{D+N}$.

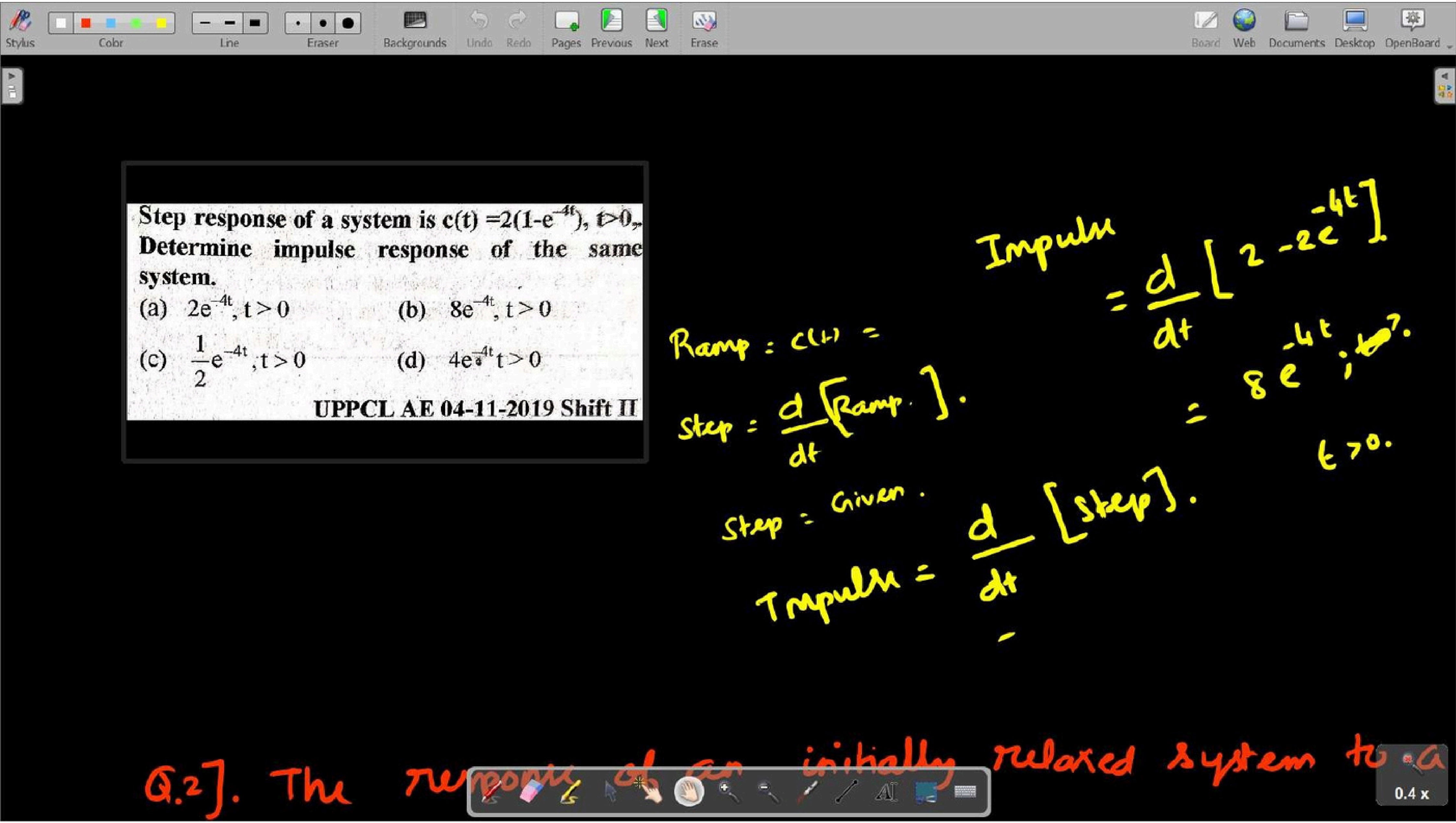
$OLTF = \frac{N}{(D+N)-N}$

$OLTF = \frac{2s+1}{s^2+2s+1-(2s+1)}$

$= \frac{2s+1}{s^2+\cancel{2s}+\cancel{1}-\cancel{2s}-\cancel{1}}$

Ⓐ

Full Video Link



Step response of a system is $c(t) = 2(1-e^{-4t})$, $t>0$, Determine impulse response of the same system.

(a) $2e^{-4t}, t>0$ (b) $8e^{-4t}, t>0$

(c) $\frac{1}{2}e^{-4t}, t>0$ (d) $4e^{-4t} t>0$

UPPCL AE 04-11-2019 Shift II

Ramp : $c(t)$ =

Step = $\frac{d}{dt}$ [Ramp].

Step = Given.

Impulse = $\frac{d}{dt}$ [Step].

Impulse

$= \frac{d}{dt}\left[2 - 2e^{-4t}\right]$

$= 8e^{-4t}$; ~~t>0~~.

$t>0$.

Q.2]. The response of an initially relaxed system to a

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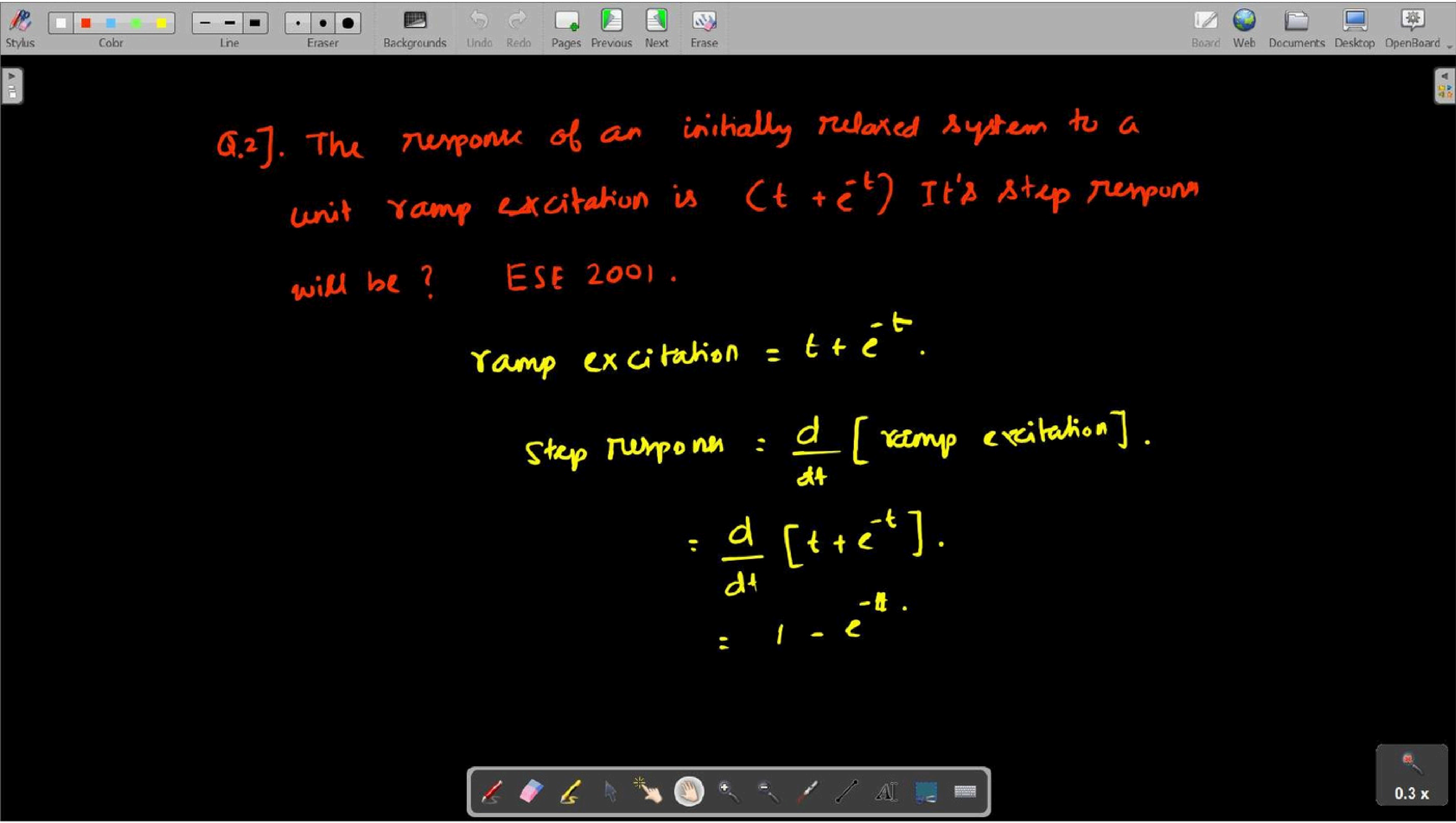

Q.2]. The response of an initially relaxed system to a unit ramp excitation is $(t + e^{-t})$ It's step response will be ? ESE 2001.

ramp excitation $= t + e^{-t}$.

Step response $= \frac{d}{dt}$ [ramp excitation].

$$= \frac{d}{dt}[t + e^{-t}].$$

$$= 1 - e^{-t}.$$

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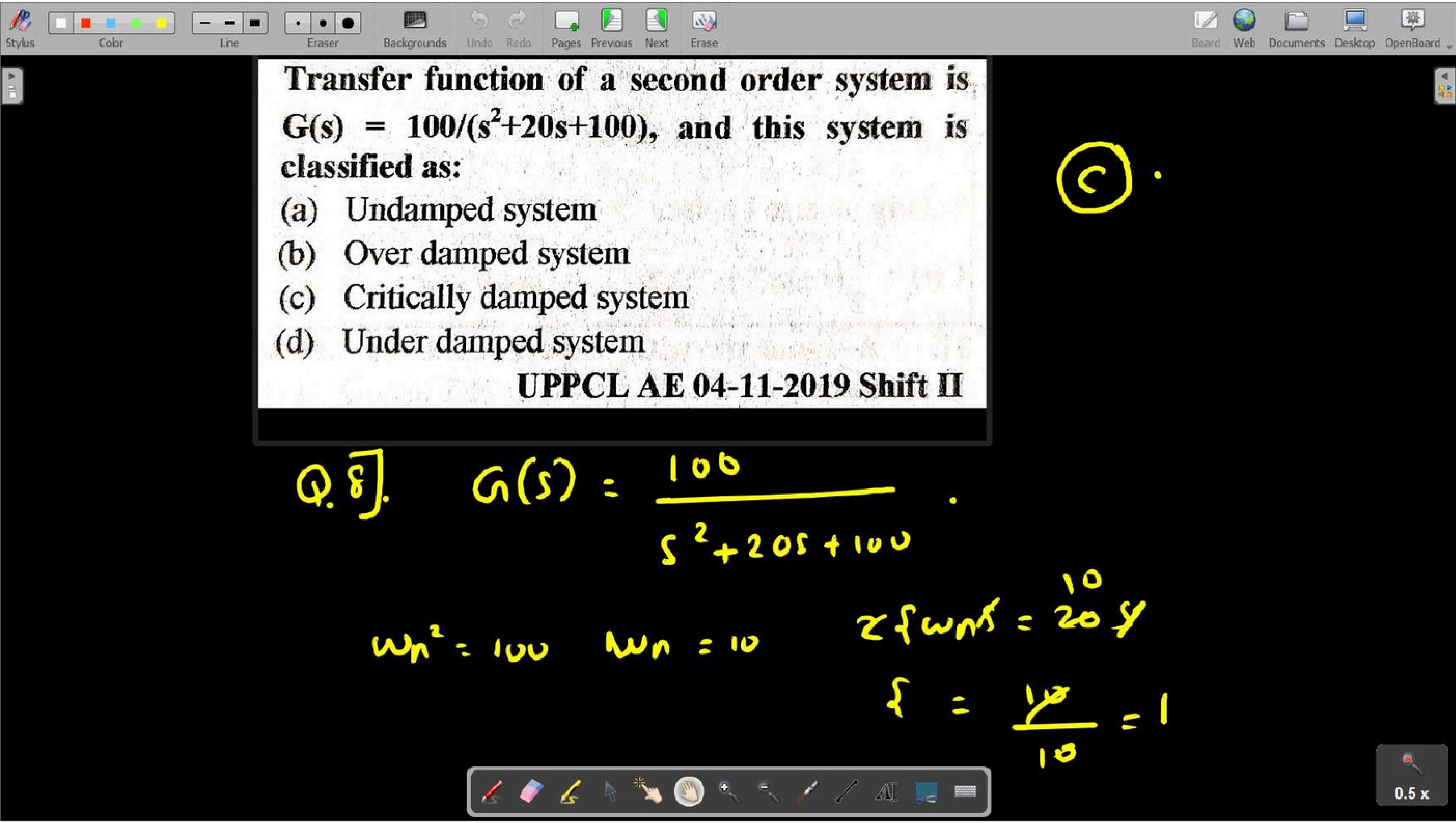


Transfer function of a second order system is G(s) = 100/(s^2+20s+100), and this system is classified as:

(a) Undamped system

(b) Over damped system

(c) Critically damped system

(d) Under damped system

UPPCL AE 04-11-2019 Shift II

$\boxed{c}$.

Q.8].

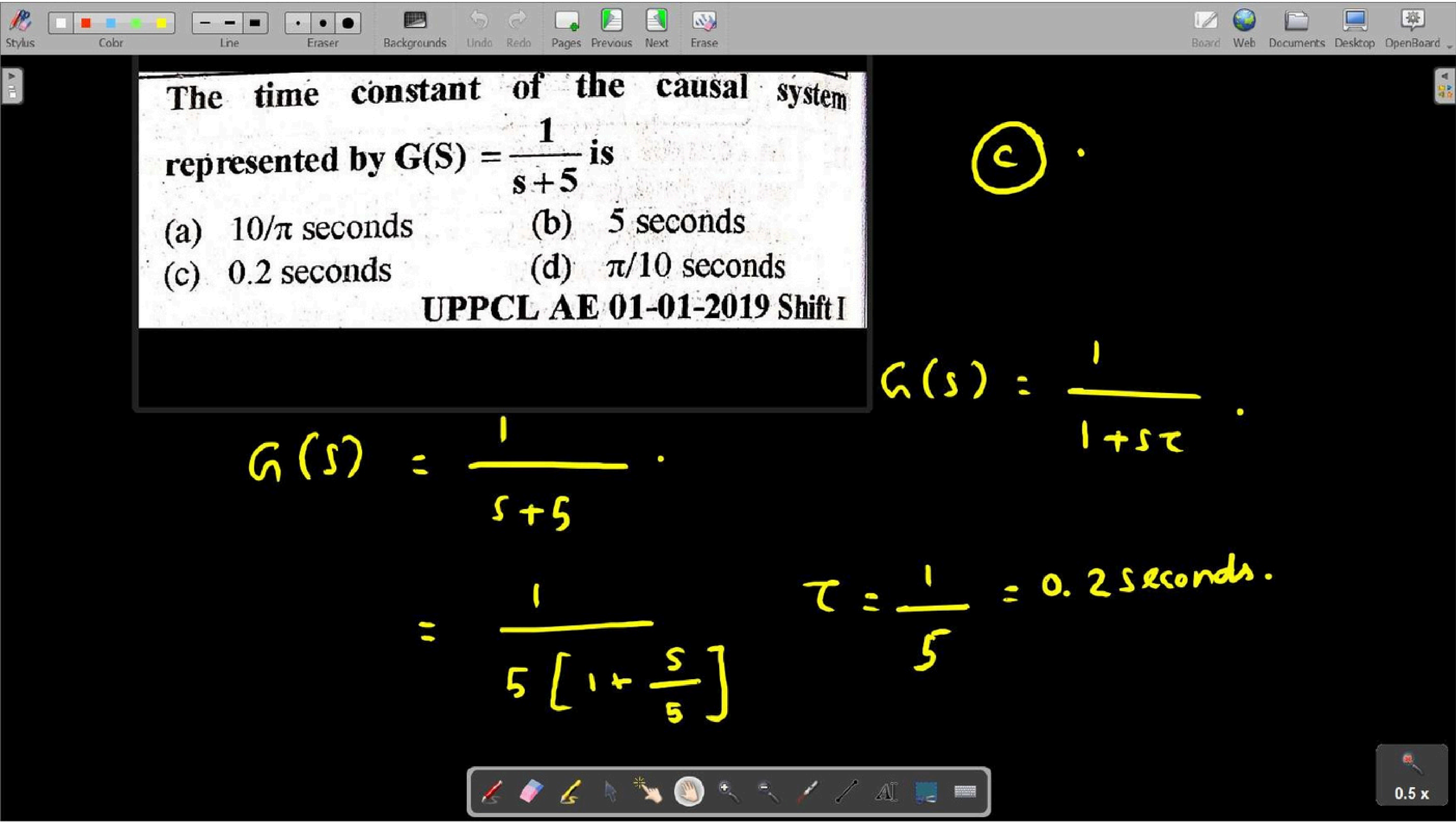
$$G(s) = \frac{100}{s^2+20s+100}.$$

$\omega_n^2 = 100$ $\omega_n = 10$

$2\zeta\omega_n = \overset{10}{20}$

$\zeta = \frac{\cancel{10}}{10} = 1$

Full Video Link



The time constant of the causal system represented by $G(S) = \dfrac{1}{s+5}$ is

(a) 10/π seconds (b) 5 seconds

(c) 0.2 seconds (d) π/10 seconds

UPPCL AE 01-01-2019 Shift I

ⓒ .

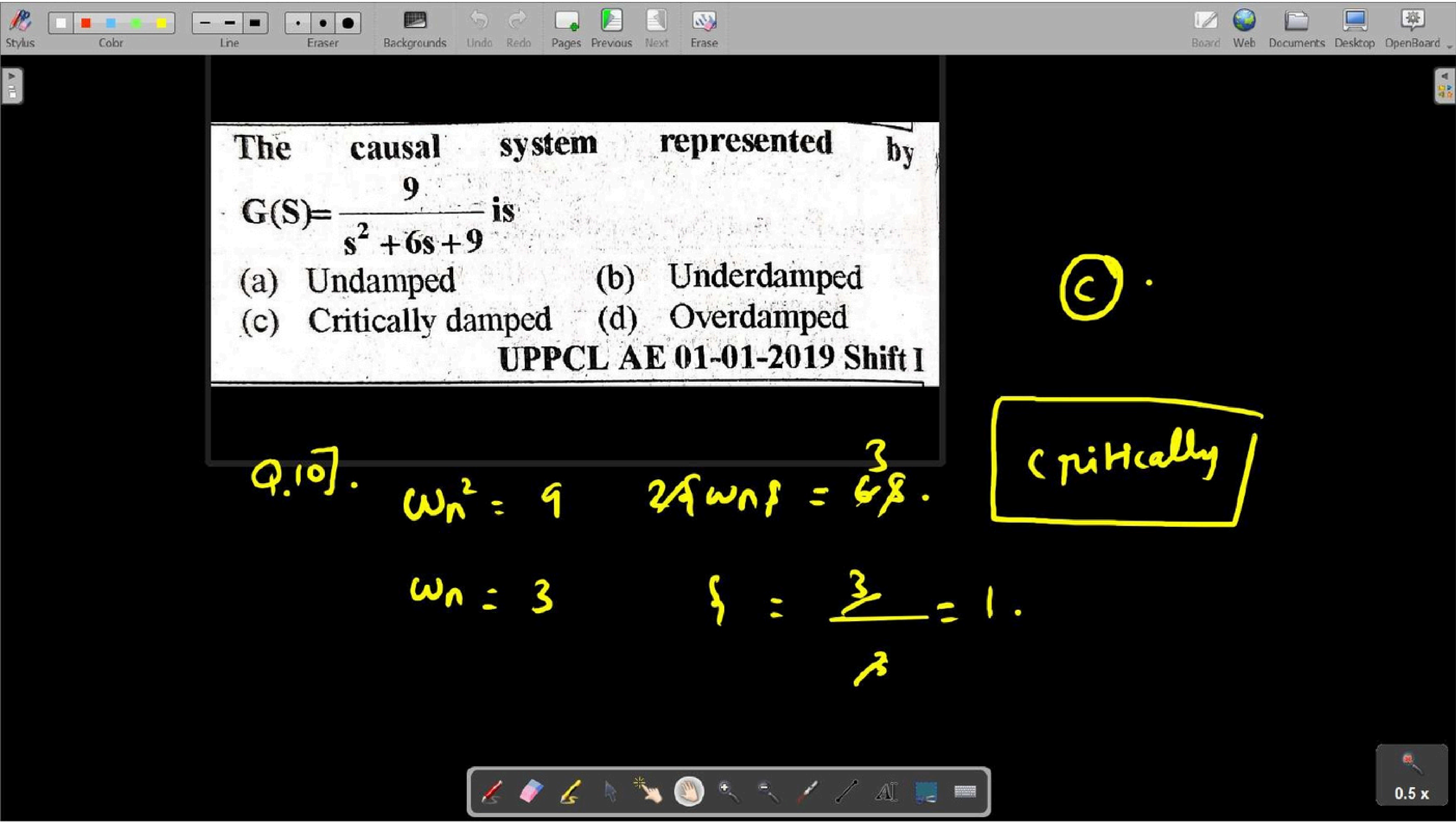
$$G(s) = \frac{1}{1+s\tau} .$$

$$G(s) = \frac{1}{s+5} .$$

$$= \frac{1}{5\left[1+\frac{s}{5}\right]}$$

$$\tau = \frac{1}{5} = 0.2 \text{ seconds.}$$

Full Video Link



The causal system represented by $G(S)=\frac{9}{s^2+6s+9}$ is

(a) Undamped (b) Underdamped

(c) Critically damped (d) Overdamped

UPPCL AE 01-01-2019 Shift I

Q.10].

$\omega_n^2 = 9$

$\cancel{2}\zeta\omega_n = \overset{3}{\cancel{6}}.$

$\omega_n = 3$

$\zeta = \frac{\cancel{3}}{\cancel{3}} = 1.$

ⓒ.

$\boxed{\text{Critically}}$

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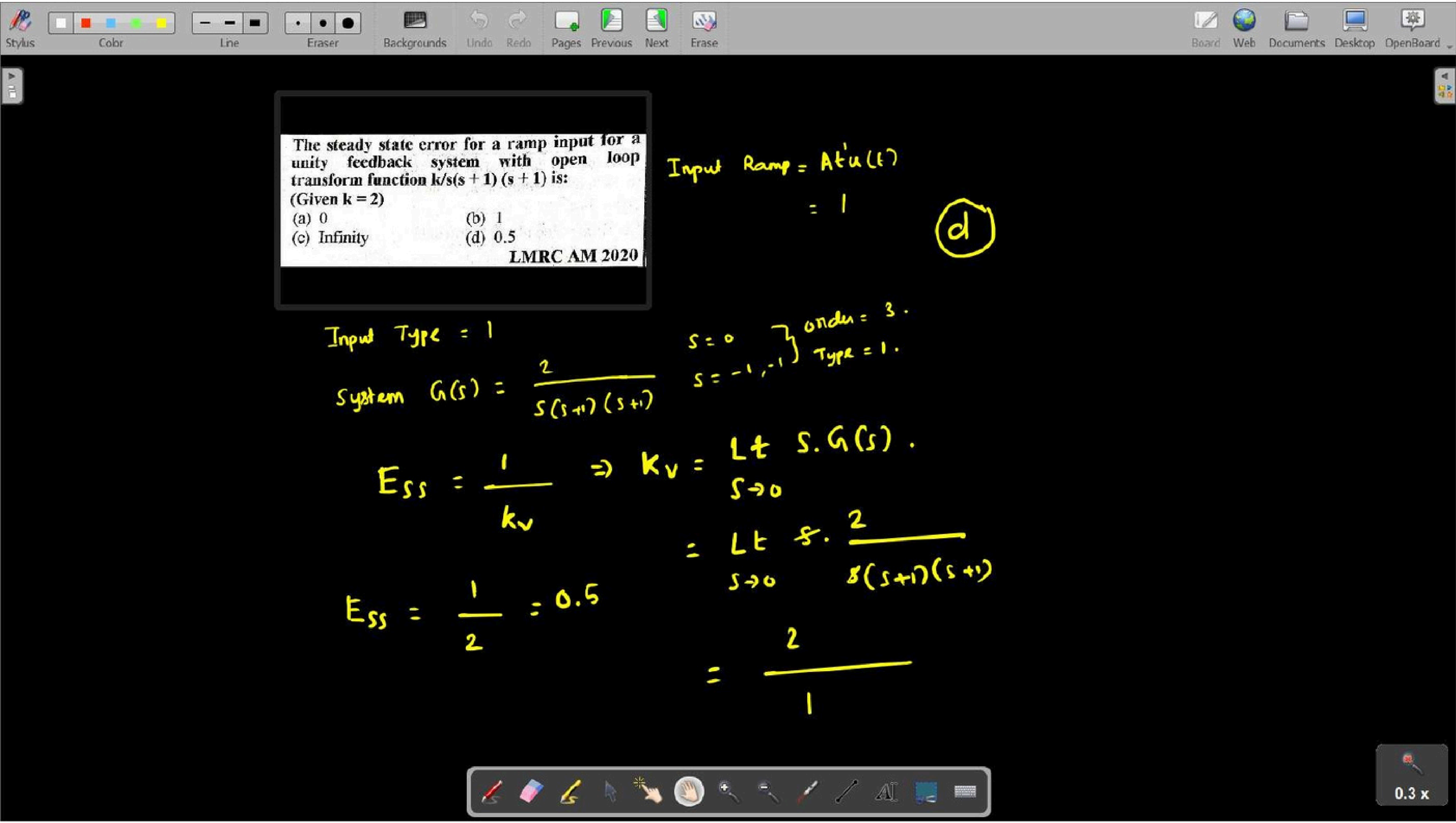

The steady state error for a ramp input for a unity feedback system with open loop transform function k/s(s + 1) (s + 1) is:
(Given k = 2)

(a) 0
(b) 1
(c) Infinity
(d) 0.5

LMRC AM 2020

Input Ramp = $At^1u(t)$

= 1

$\bigcirc d$

Input Type = 1

$s = 0$, $s = -1, -1$ } order = 3. Type = 1.

System $G(s) = \frac{2}{s(s+1)(s+1)}$

$$E_{ss} = \frac{1}{k_v} \Rightarrow K_v = \underset{s\to 0}{Lt}\ s.G(s).$$

$$= \underset{s\to 0}{Lt}\ \cancel{s}.\frac{2}{\cancel{s}(s+1)(s+1)}$$

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

$$E_{ss} = \frac{1}{2} = 0.5$$

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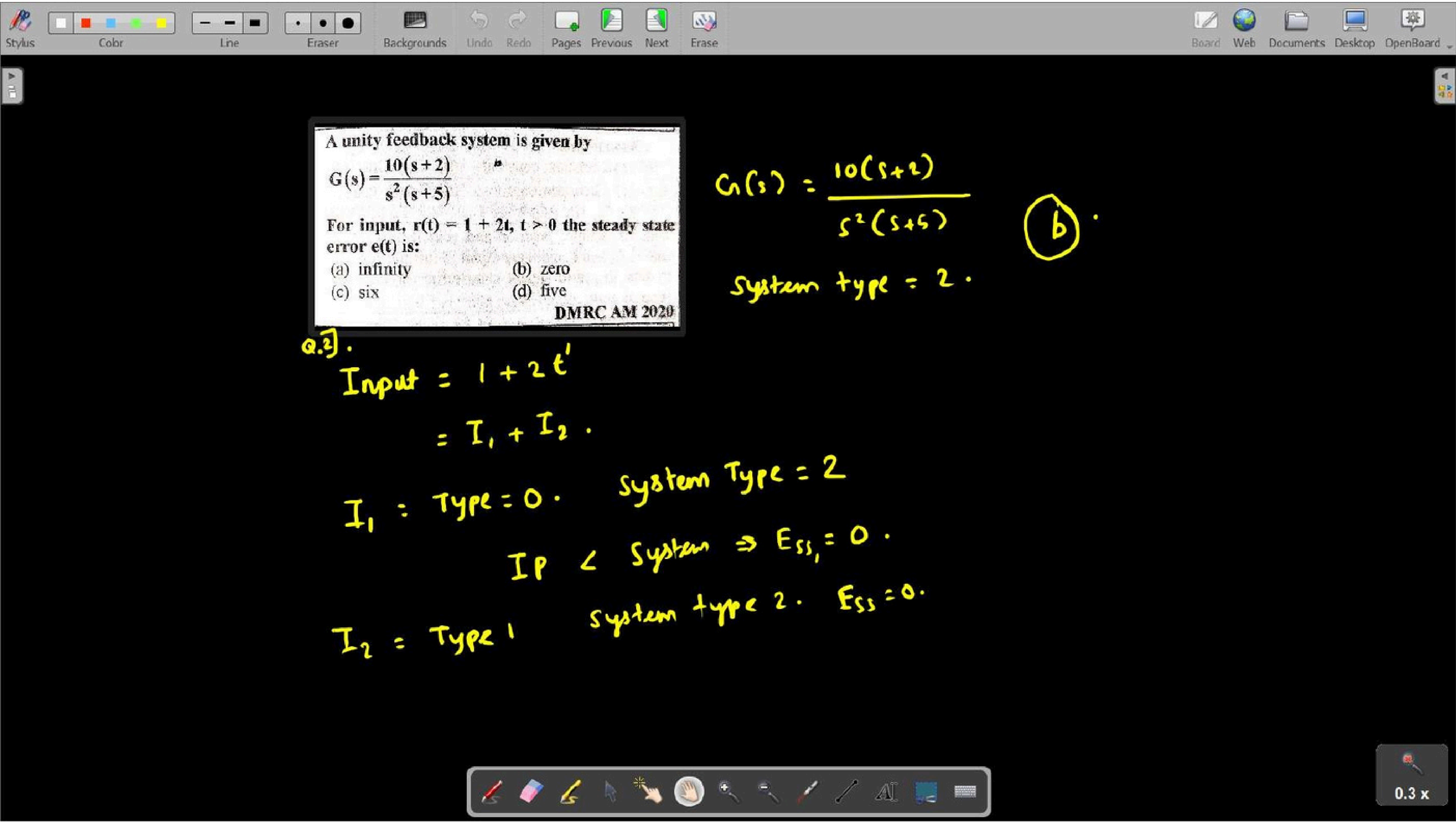

A unity feedback system is given by

$$G(s)=\frac{10(s+2)}{s^2(s+5)}$$

For input, r(t) = 1 + 2t, t > 0 the steady state error e(t) is:

(a) infinity (b) zero

(c) six (d) five

DMRC AM 2020

$$G(s) = \frac{10(s+2)}{s^2(s+5)}$$ ⓑ.

System type = 2.

Q.$\boxed{2}$.

Input = $1 + 2t'$

$= I_1 + I_2$.

I_1 : Type = 0. System Type = 2

IP < System ⇒ $E_{ss_1} = 0$.

I_2 = Type 1 system type 2. $E_{ss} = 0$.

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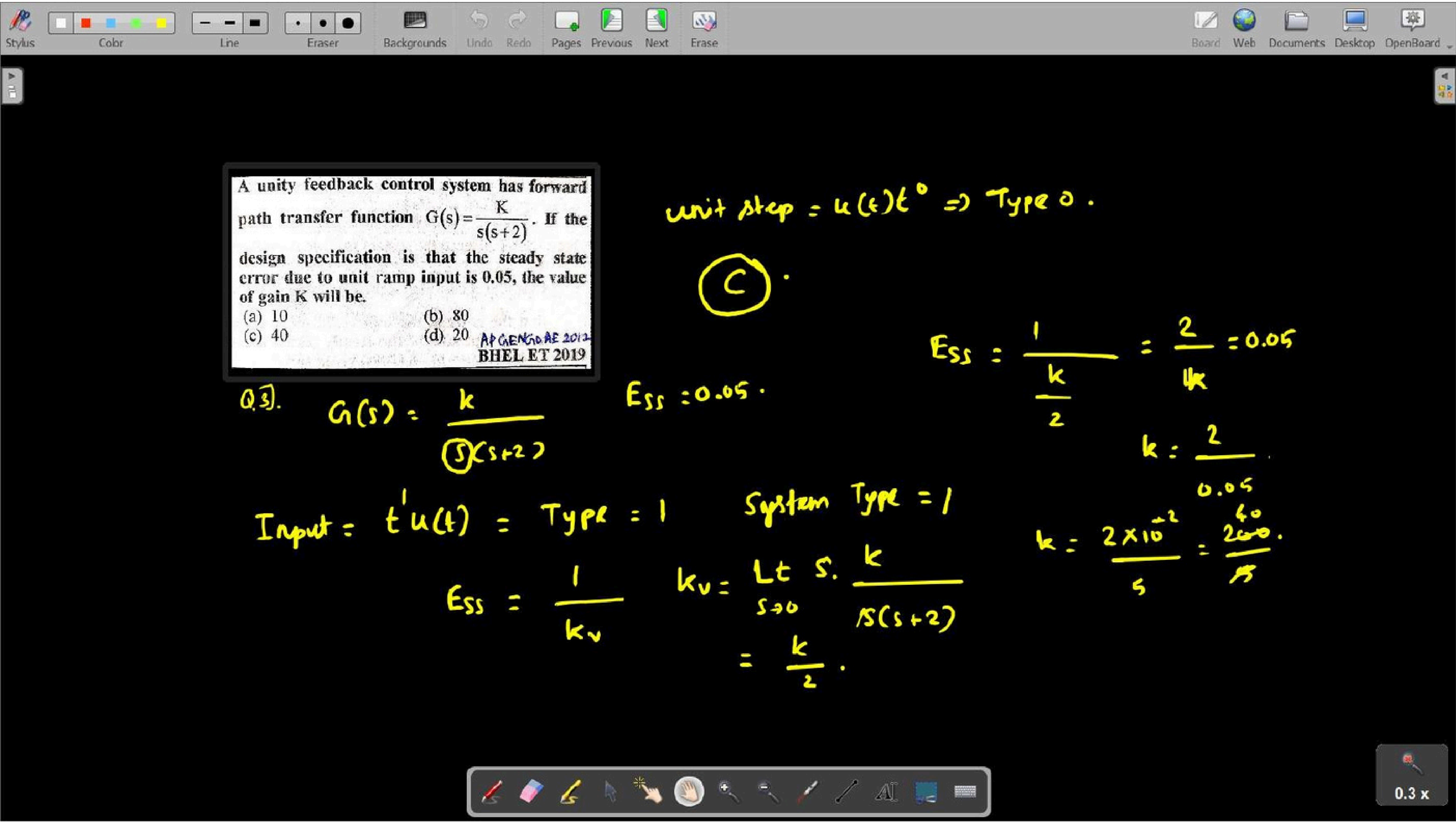

A unity feedback control system has forward path transfer function $G(s)=\frac{K}{s(s+2)}$. If the design specification is that the steady state error due to unit ramp input is 0.05, the value of gain K will be.

(a) 10 (b) 80

(c) 40 (d) 20

AP GENCO AE 2012

BHEL ET 2019

unit step = $u(t)t^{0} \Rightarrow$ Type 0.

Ⓒ.

Q.3).

$$G(s) = \frac{k}{s(s+2)}$$

$E_{ss} = 0.05.$

Input = $t^{1}u(t)$ = Type = 1   System Type = 1

$$E_{ss} = \frac{1}{k_v} \qquad k_v = \underset{s\to 0}{Lt}\ s.\frac{k}{\cancel{s}(s+2)} = \frac{k}{2}.$$

$$E_{ss} = \frac{1}{\frac{k}{2}} = \frac{2}{k} = 0.05$$

$$k = \frac{2}{0.05}.$$

$$k = \frac{2\times10^{2}}{5} = \frac{\overset{40}{\cancel{200}}}{\cancel{5}}.$$

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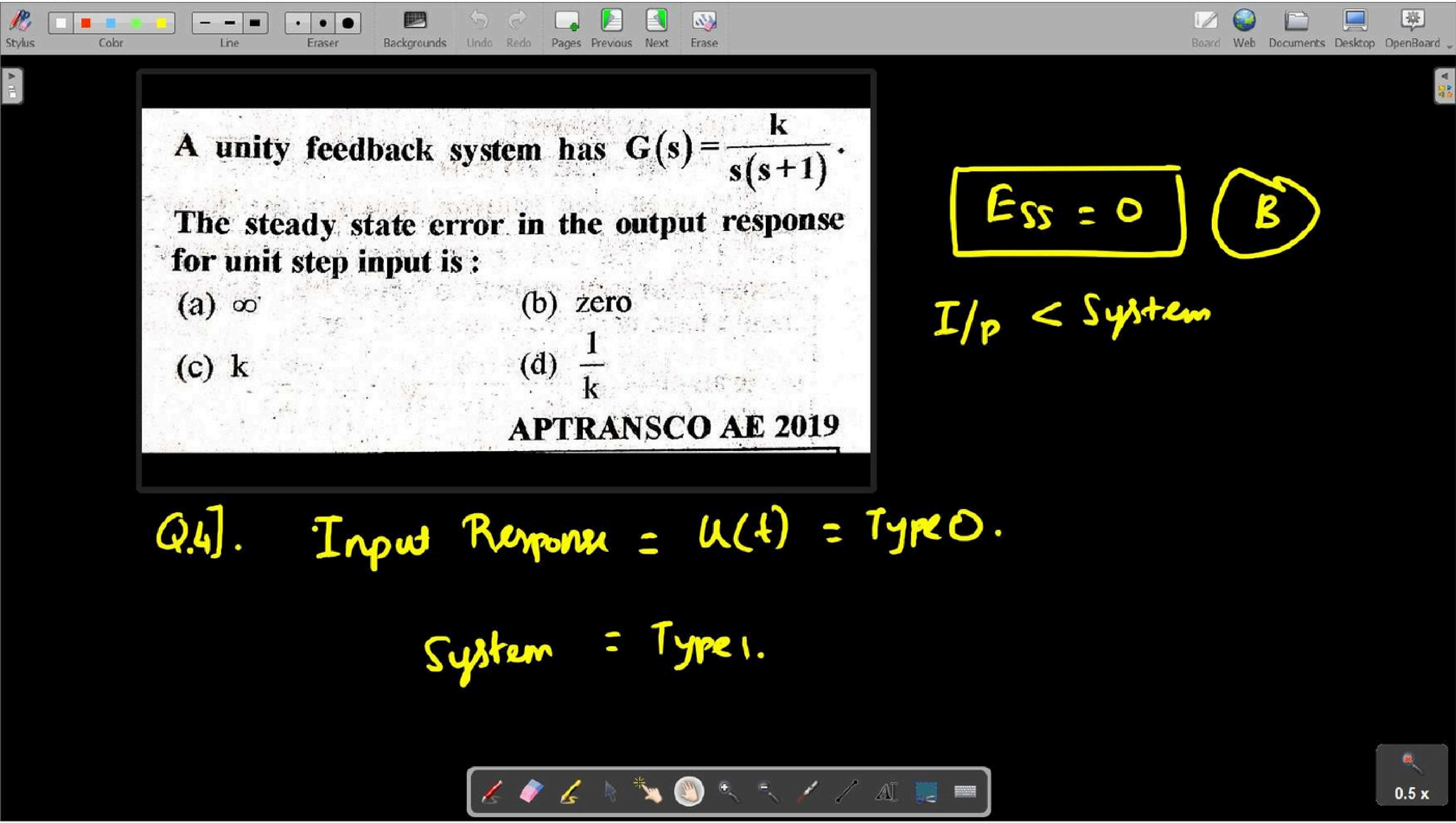


A unity feedback system has $G(s) = \frac{k}{s(s+1)}$.

The steady state error in the output response for unit step input is :

(a) ∞ (b) zero

(c) k (d) $\frac{1}{k}$

APTRANSCO AE 2019

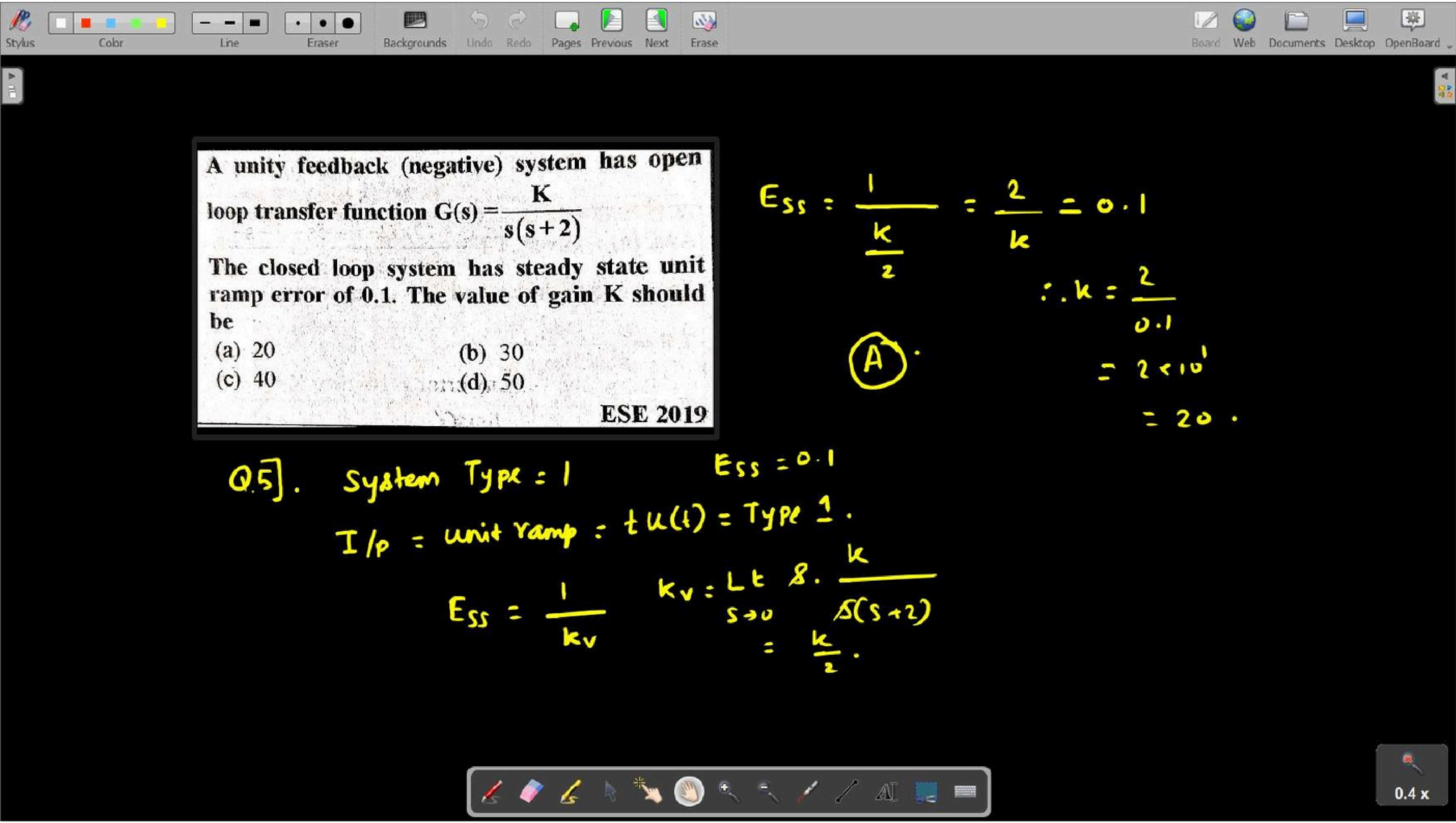
$\boxed{E_{ss} = 0}$ B

I/p < System

Q.4]. Input Response = u(t) = Type 0.

System = Type 1.

Full Video Link



A unity feedback (negative) system has open loop transfer function $G(s) = \dfrac{K}{s(s+2)}$

The closed loop system has steady state unit ramp error of 0.1. The value of gain K should be

(a) 20 (b) 30

(c) 40 (d) 50

ESE 2019

$$E_{ss} = \frac{1}{\frac{k}{2}} = \frac{2}{k} = 0.1$$

$$\therefore k = \frac{2}{0.1}$$

$$= 2 \times 10^1$$

$$= 20.$$

$\boxed{A}$.

Q.5]. System Type : 1 $\quad E_{ss} = 0.1$

I/p = unit ramp = $t\,u(t)$ = Type 1.

$$E_{ss} = \frac{1}{k_v} \qquad k_v = \lim_{s \to 0} \cancel{s}.\frac{k}{\cancel{s}(s+2)}$$

$$= \frac{k}{2}.$$

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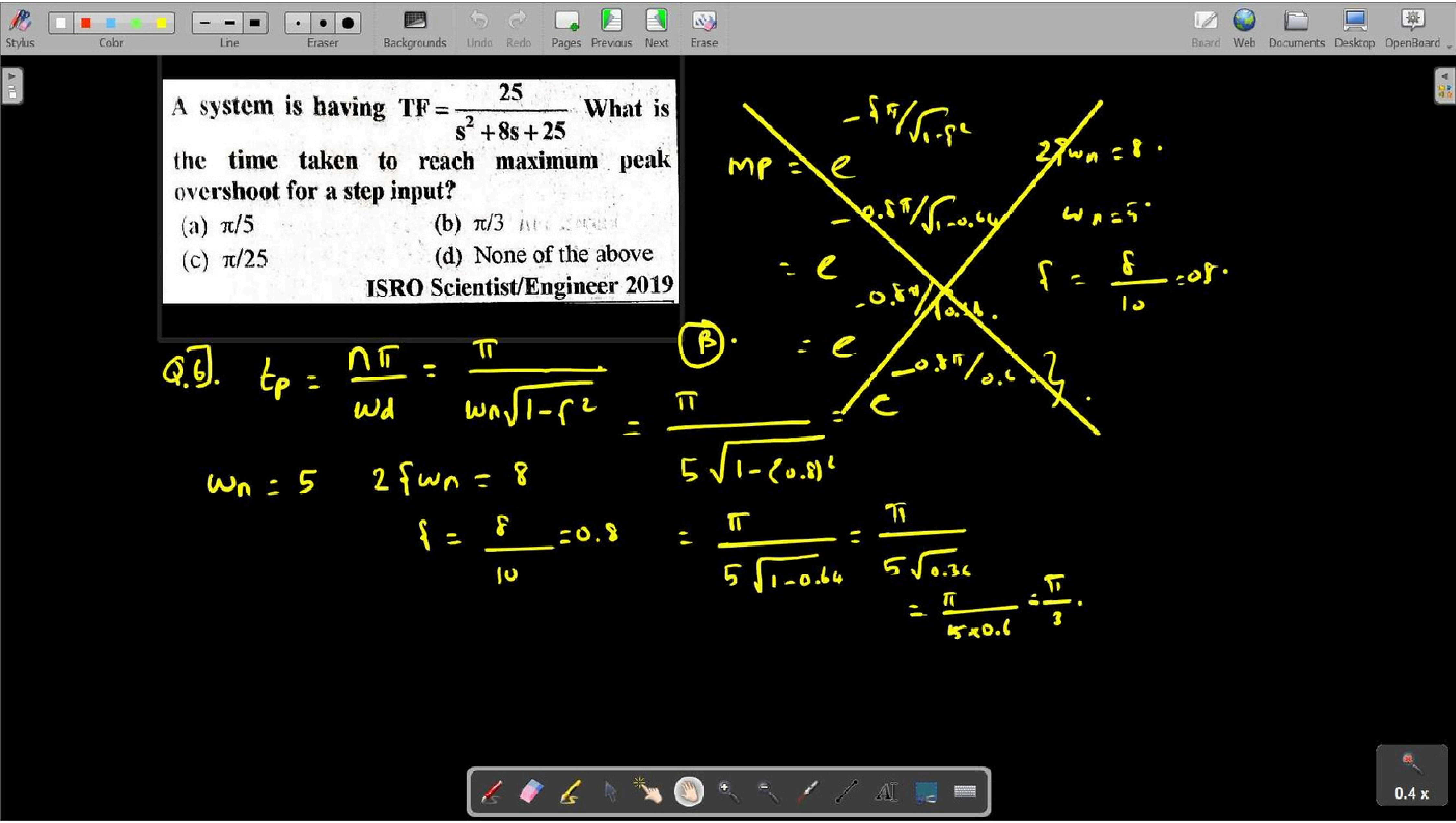


A system is having TF $= \frac{25}{s^2+8s+25}$ What is the time taken to reach maximum peak overshoot for a step input?

(a) $\pi/5$

(b) $\pi/3$

(c) $\pi/25$

(d) None of the above

ISRO Scientist/Engineer 2019

Q.$\boxed{6}$. $t_p = \frac{n\pi}{\omega_d} = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} = \frac{\pi}{5\sqrt{1-(0.8)^2}}$

$\omega_n = 5 \quad 2\zeta\omega_n = 8$

$\zeta = \frac{8}{10} = 0.8$

$= \frac{\pi}{5\sqrt{1-0.64}} = \frac{\pi}{5\sqrt{0.36}}$

$= \frac{\pi}{5\times 0.6} = \frac{\pi}{3}.$

$\textcircled{B}$.

~~$MP = e^{-\zeta\pi/\sqrt{1-\zeta^2}}$~~

~~$= e^{-0.8\pi/\sqrt{1-0.64}}$~~

~~$= e^{-0.8\pi/0.36}$~~

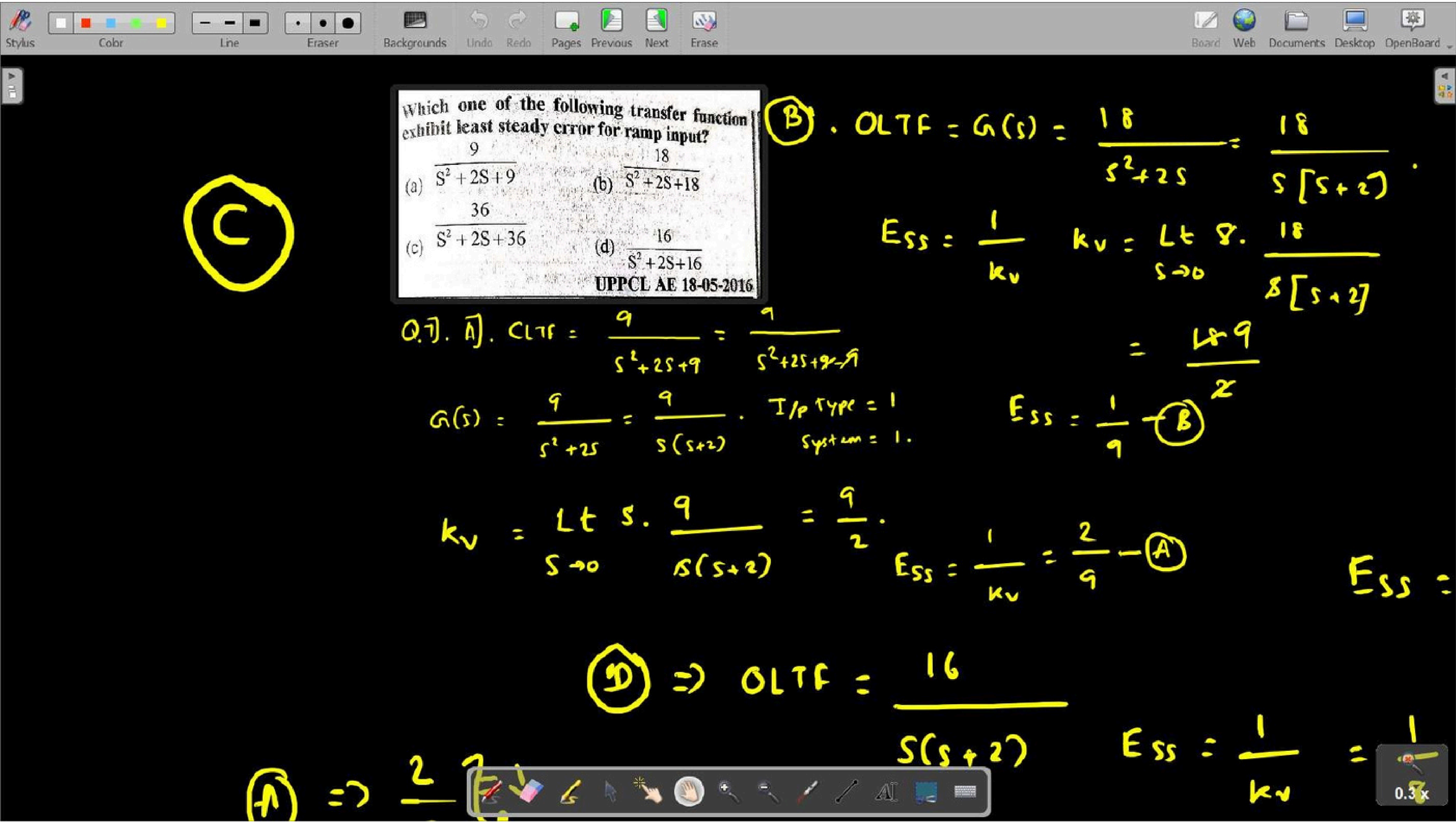
~~$= e^{-0.8\pi/0.6}$.~~

~~$2\zeta\omega_n = 8$.~~

~~$\omega_n = 5$.~~

~~$\zeta = \frac{8}{10} = 0.8$.~~

Full Video Link



Ⓒ

Which one of the following transfer function exhibit least steady error for ramp input?

(a) $\frac{9}{S^2+2S+9}$ (b) $\frac{18}{S^2+2S+18}$

(c) $\frac{36}{S^2+2S+36}$ (d) $\frac{16}{S^2+2S+16}$

UPPCL AE 18-05-2016

Q.7. A). $CLTF = \frac{9}{s^2+2s+9} = \frac{9}{s^2+2s+\cancel{9}-\cancel{9}}$

$G(s) = \frac{9}{s^2+2s} = \frac{9}{s(s+2)}$. I/p type = 1
System = 1.

$k_v = \underset{s\to 0}{Lt}\ s.\frac{9}{s(s+2)} = \frac{9}{2}$.

$E_{ss} = \frac{1}{k_v} = \frac{2}{9}$ — Ⓐ

Ⓑ. $OLTF = G(s) = \frac{18}{s^2+2s} = \frac{18}{s[s+2]}$.

$E_{ss} = \frac{1}{k_v}$ $k_v = \underset{s\to 0}{Lt}\ \cancel{s}.\frac{18}{\cancel{s}[s+2]}$

$= \frac{\cancel{18}\,9}{\cancel{2}}$

$E_{ss} = \frac{1}{9}$ — Ⓑ

$E_{ss} =$

Ⓓ $\Rightarrow OLTF = \frac{16}{S(s+2)}$ $E_{ss} = \frac{1}{k_v} = \frac{1}{}$

Ⓐ $\Rightarrow \frac{2}{}$

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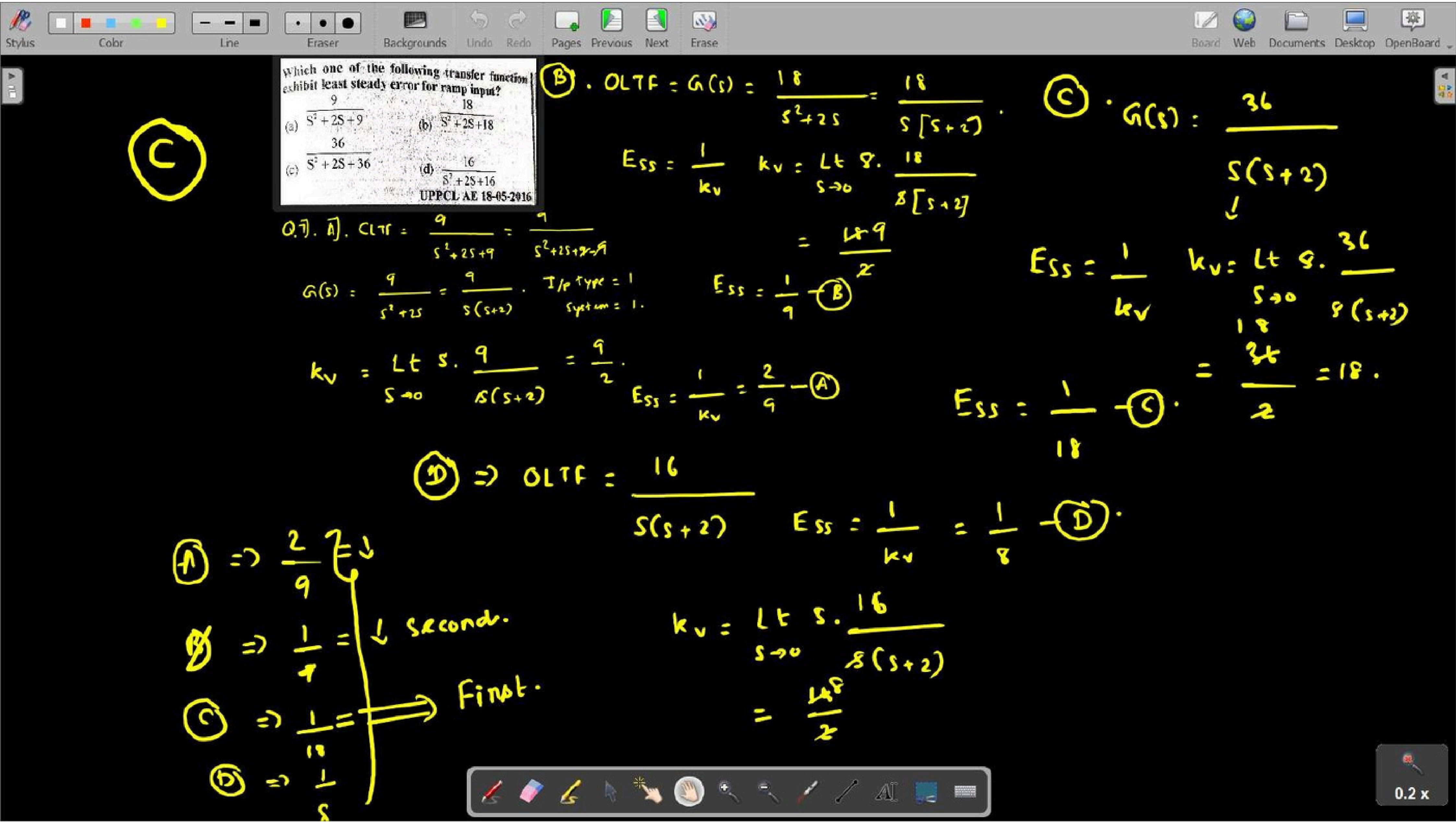


Which one of the following transfer function exhibit least steady error for ramp input?

(a) $\frac{9}{S^2+2S+9}$ (b) $\frac{18}{S^2+2S+18}$

(c) $\frac{36}{S^2+2S+36}$ (d) $\frac{16}{S^2+2S+16}$

UPPCL AE 18-05-2016

$\textcircled{C}$

Q.7). A). CLTF $= \frac{9}{s^2+2s+9} = \frac{9}{s^2+2s+\cancel{9}-\cancel{9}}$

$G(s) = \frac{9}{s^2+2s} = \frac{9}{s(s+2)}$. I/p type = 1, System = 1.

$k_v = \underset{s \to 0}{Lt}\ \cancel{s}.\frac{9}{\cancel{s}(s+2)} = \frac{9}{2}$.

$E_{ss} = \frac{1}{k_v} = \frac{2}{9}$ — Ⓐ

Ⓑ. OLTF = $G(s) = \frac{18}{s^2+2s} = \frac{18}{s[s+2]}$.

$E_{ss} = \frac{1}{k_v}$ $k_v = \underset{s \to 0}{Lt}\ \cancel{s}.\frac{18}{\cancel{s}[s+2]}$

$= \frac{\cancel{18}\,9}{\cancel{2}}$

$E_{ss} = \frac{1}{9}$ — Ⓑ

Ⓒ. $G(s) = \frac{36}{s(s+2)}$

$E_{ss} = \frac{1}{k_v}$ $k_v = \underset{s \to 0}{Lt}\ \cancel{s}.\frac{36}{\cancel{s}(s+2)}$

$= \frac{\cancel{36}\,18}{\cancel{2}} = 18$.

$E_{ss} = \frac{1}{18}$ — Ⓒ.

Ⓓ ⇒ OLTF = $\frac{16}{s(s+2)}$ $E_{ss} = \frac{1}{k_v} = \frac{1}{8}$ — Ⓓ.

$k_v = \underset{s \to 0}{Lt}\ \cancel{s}.\frac{16}{\cancel{s}(s+2)}$

$= \frac{\cancel{16}\,8}{\cancel{2}}$

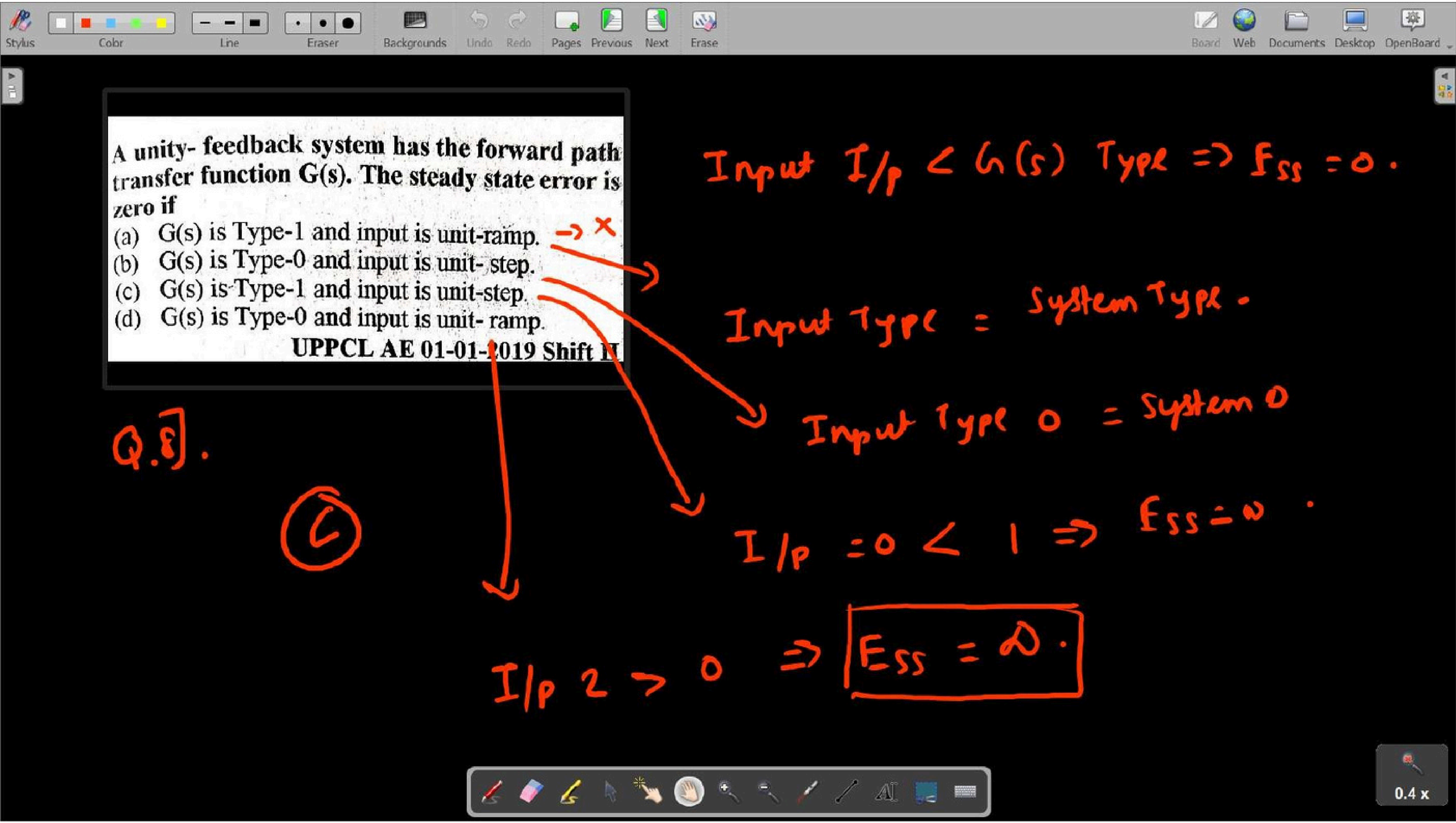
Ⓐ ⇒ $\frac{2}{9}$ = ↓

~~Ⓑ~~ ⇒ $\frac{1}{9}$ = ↓ second.

Ⓒ ⇒ $\frac{1}{18}$ = ⟹ First.

Ⓓ ⇒ $\frac{1}{8}$

Full Video Link



A unity- feedback system has the forward path transfer function G(s). The steady state error is zero if

(a) G(s) is Type-1 and input is unit-ramp. → ×

(b) G(s) is Type-0 and input is unit- step.

(c) G(s) is Type-1 and input is unit-step.

(d) G(s) is Type-0 and input is unit- ramp.

UPPCL AE 01-01-2019 Shift II

Q.8].

ⓒ

Input I/p $<$ G(s) Type $\Rightarrow E_{ss} = 0$.

Input Type = System Type.

Input Type 0 = System 0

I/p $= 0 < 1 \Rightarrow E_{ss} = \infty$.

I/p $2 > 0 \Rightarrow \boxed{E_{ss} = \infty.}$

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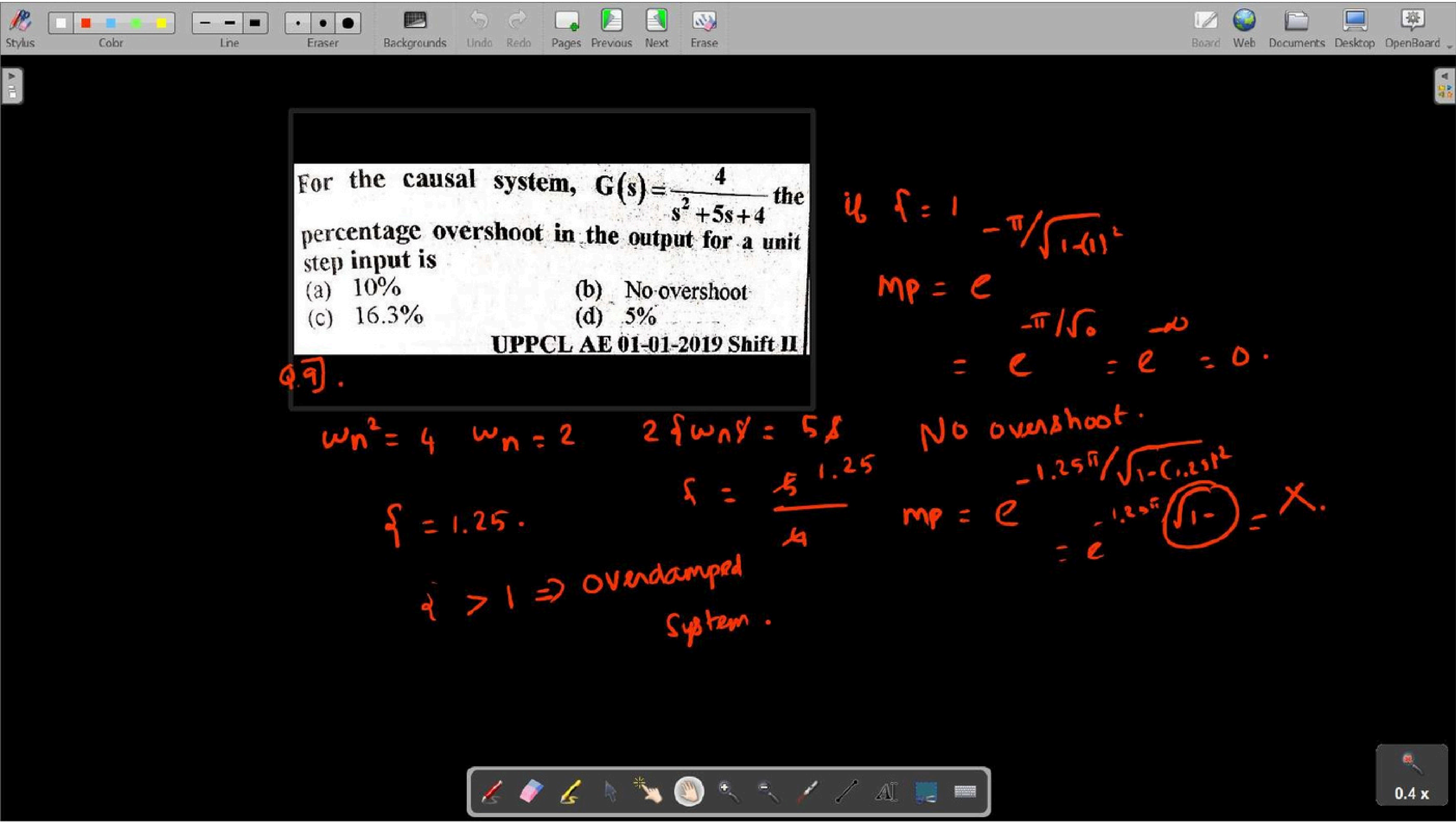

For the causal system, $G(s)=\frac{4}{s^2+5s+4}$ the percentage overshoot in the output for a unit step input is

(a) 10% (b) No overshoot

(c) 16.3% (d) 5%

UPPCL AE 01-01-2019 Shift II

Q.9].

$\omega_n^2 = 4 \quad \omega_n = 2$

$2\xi\omega_n s = 5s$

$\xi = \frac{\cancel{5}\ 1.25}{\cancel{4}}$

$\xi = 1.25.$

$\xi > 1 \Rightarrow$ overdamped system.

if $\xi = 1$

$M_p = e^{-\pi/\sqrt{1-(1)^2}}$

$= e^{-\pi/\sqrt{0}} = e^{-\infty} = 0.$

No overshoot.

$m_p = e^{-1.25\pi/\sqrt{1-(1.25)^2}}$

$= e^{-1.25\pi/\boxed{\sqrt{1-}}} = \times.$

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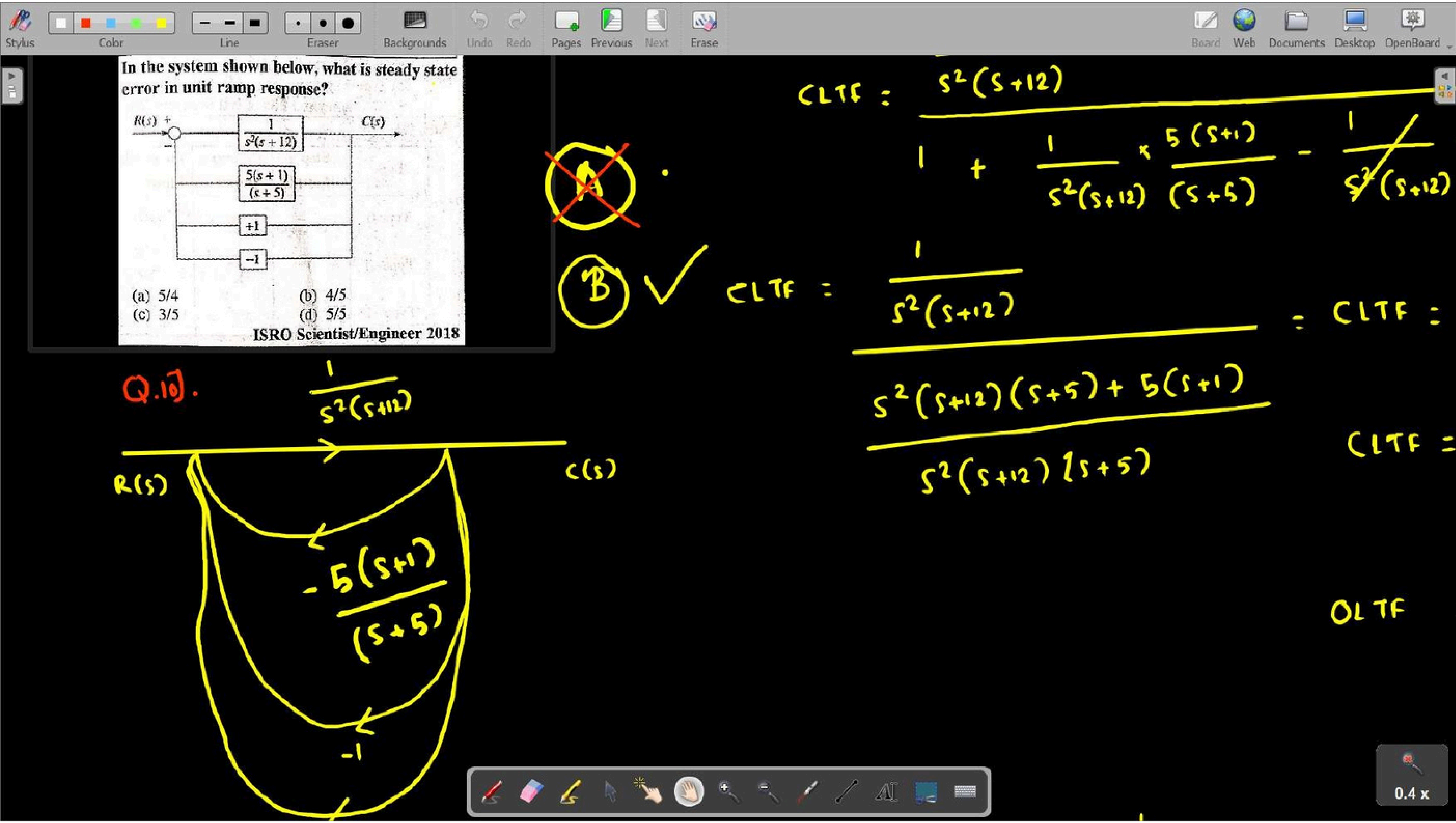

In the system shown below, what is steady state error in unit ramp response?

(a) 5/4 (b) 4/5

(c) 3/5 (d) 5/5

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Q.10.

$\frac{1}{s^2(s+12)}$

R(s)

C(s)

$-\frac{5(s+1)}{(s+5)}$

-1

$$CLTF = \frac{s^2(s+12)}{1 + \frac{1}{s^2(s+12)} \times \frac{5(s+1)}{(s+5)} - \frac{1}{\cancel{s^2}(s+12)}}$$

~~A~~ .

B ✓

$$CLTF = \frac{\frac{1}{s^2(s+12)}}{\frac{s^2(s+12)(s+5)+5(s+1)}{s^2(s+12)(s+5)}} = CLTF :$$

CLTF =

OL TF

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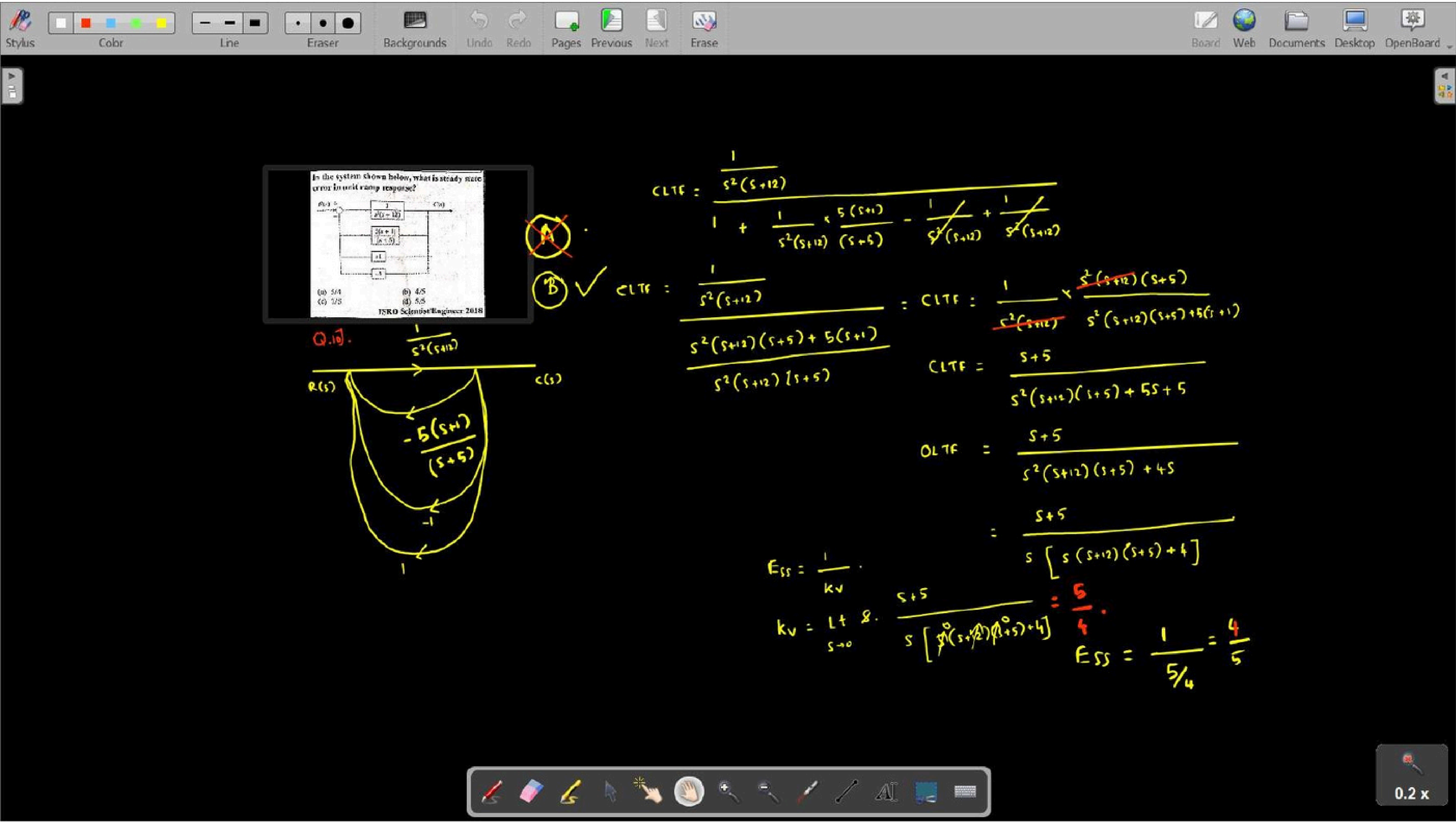


In the system shown below, what is steady state error in unit ramp response?

(a) 5/4
(b) 4/5
(c) 2/5
(d) 5/5

ISRO Scientist/Engineer 2018

Q.10.

~~(A)~~ .

(B) ✓

$$CLTF = \frac{\frac{1}{s^2(s+12)}}{1 + \frac{1}{s^2(s+12)} \times \frac{5(s+1)}{(s+5)} - \frac{1}{\cancel{s^2}(s+12)} + \frac{1}{\cancel{s^2}(s+12)}}$$

$$CLTF = \frac{\frac{1}{s^2(s+12)}}{\frac{s^2(s+12)(s+5) + 5(s+1)}{s^2(s+12)(s+5)}} = CLTF = \frac{1}{\cancel{s^2(s+12)}} \times \frac{\cancel{s^2(s+12)}(s+5)}{s^2(s+12)(s+5)+5(s+1)}$$

$$CLTF = \frac{s+5}{s^2(s+12)(s+5) + 5s + 5}$$

$$OLTF = \frac{s+5}{s^2(s+12)(s+5) + 4s}$$

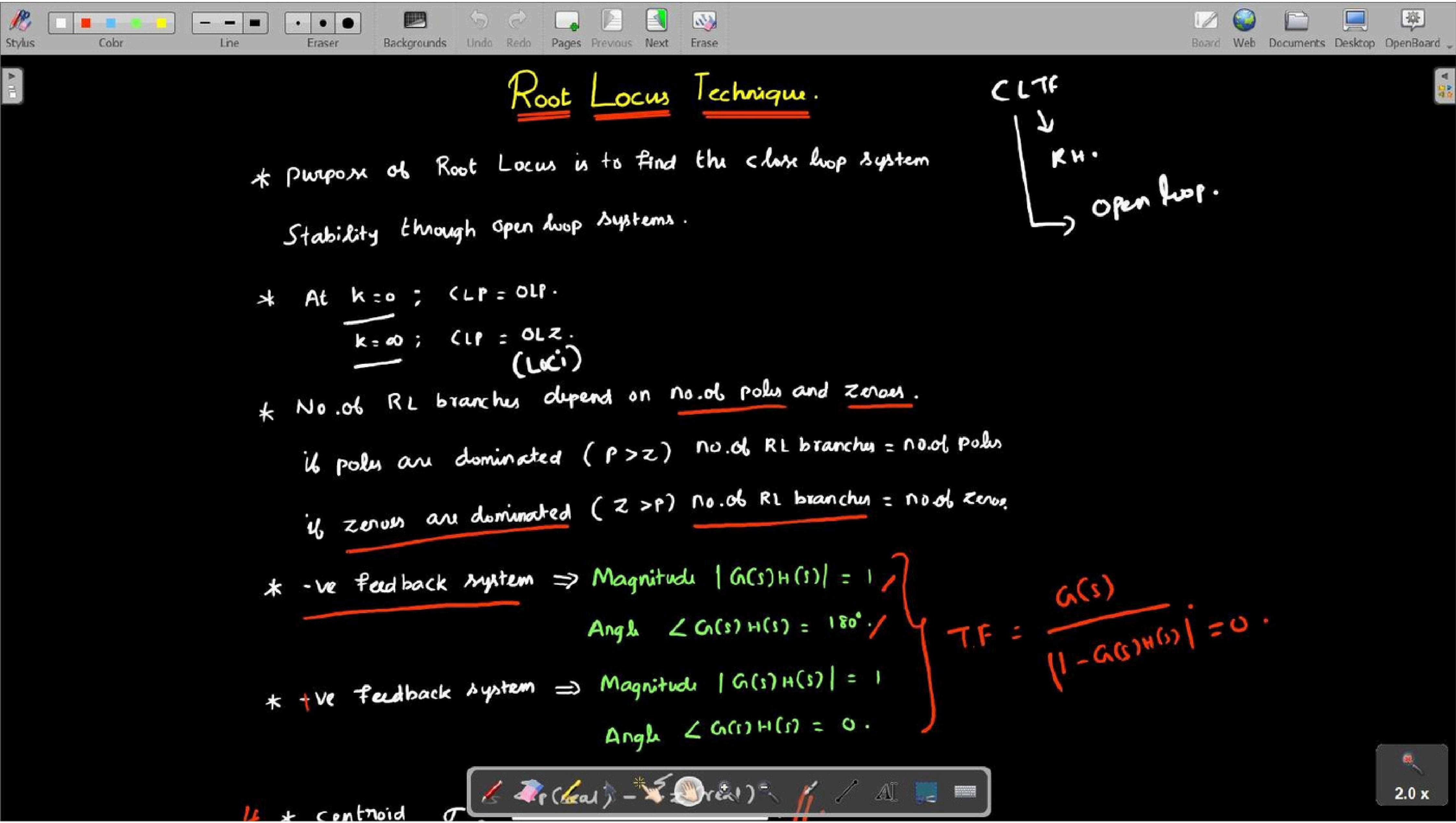
$$= \frac{s+5}{s\left[s(s+12)(s+5) + 4\right]}$$

$$E_{ss} = \frac{1}{k_v}.$$

$$k_v = \lim_{s \to 0} s \cdot \frac{s+5}{s\left[\overset{0}{\cancel{s}}(s+12)(\overset{0}{\cancel{s}}+5)+4\right]} = \frac{5}{4}.$$

$$E_{ss} = \frac{1}{5/4} = \frac{4}{5}$$

Full Video Link



Root Locus Technique.

CLTF
↓ RH.
↳ open loop.

* Purpose of Root Locus is to find the close loop system Stability through open loop systems.

* At $k = 0$; CLP = OLP.

$k = \infty$; CLP = OLZ.
(Loci)

* No. of RL branches depend on no. of poles and zeroes.

if poles are dominated ($P > Z$) no. of RL branches = no. of poles

if zeroes are dominated ($Z > P$) no. of RL branches = no. of zeroes

* -ve feedback system ⇒ Magnitude $|G(s)H(s)| = 1$

Angle $\angle G(s)H(s) = 180°$.

* +ve feedback system ⇒ Magnitude $|G(s)H(s)| = 1$

Angle $\angle G(s)H(s) = 0$.

$$T.F = \frac{G(s)}{|1 - G(s)H(s)|} = 0.$$

* centroid

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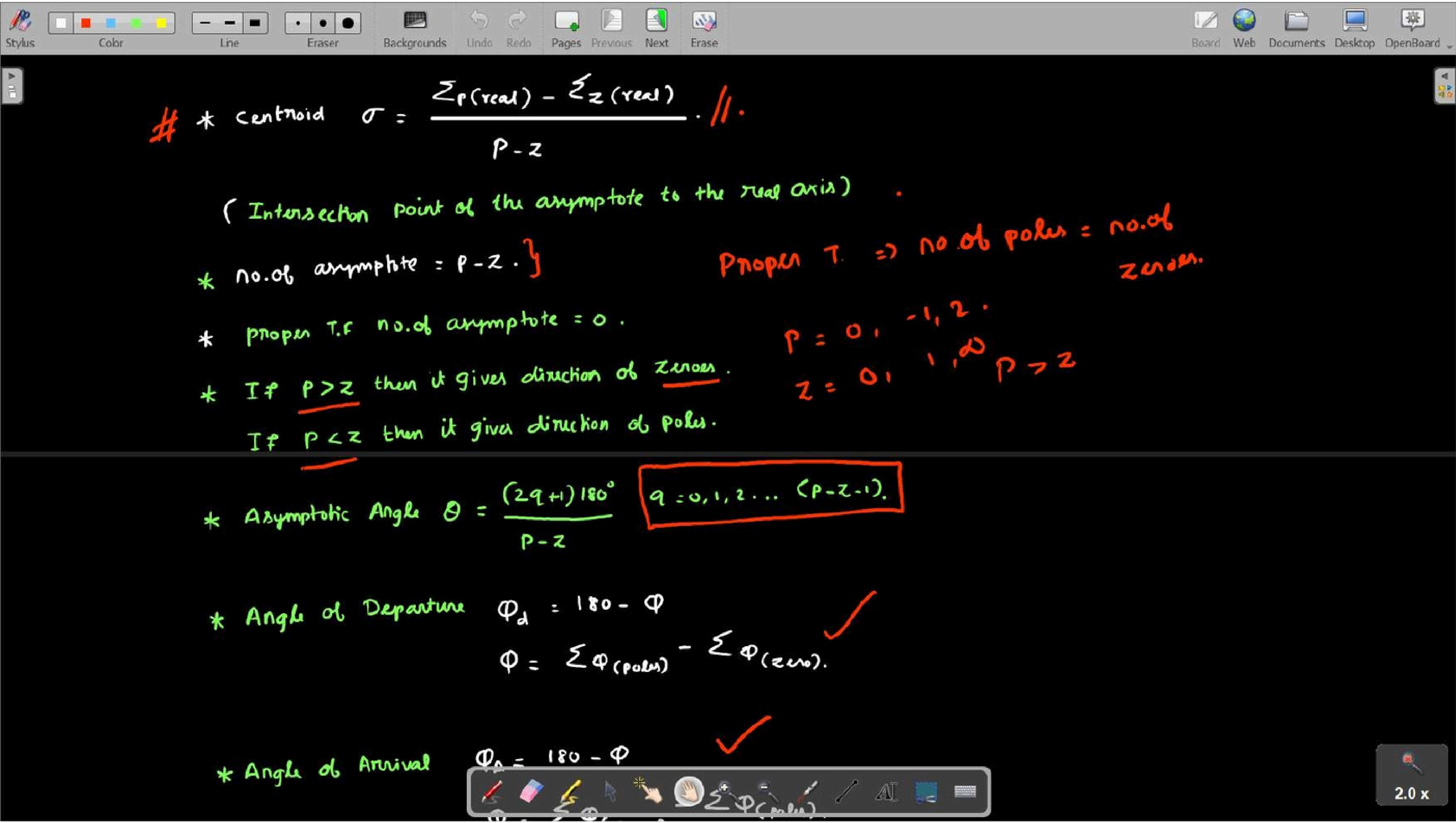

* centroid $\sigma = \dfrac{\Sigma_{p}(\text{real}) - \Sigma_{z}(\text{real})}{P - Z}$. //.

(Intersection point of the asymptote to the real axis) .

* no. of asymptote = P - Z . }

Proper T. => no. of poles = no. of zeroes.

* proper T.F no. of asymptote = 0 .

$P = 0, -1, 2.$

$Z = 0, 1, \infty$ $P > Z$

* If $P > Z$ then it gives direction of zeroes .

If $P < Z$ then it gives direction of poles .

* Asymptotic Angle $\theta = \dfrac{(2q+1)180^\circ}{P - Z}$ $\boxed{q = 0, 1, 2 \ldots (P - Z - 1).}$

* Angle of Departure $\Phi_d = 180 - \Phi$ ✓

$\Phi = \Sigma\Phi_{(\text{poles})} - \Sigma\Phi_{(\text{zero})}.$

* Angle of Arrival $\Phi_A = 180 - \Phi$ ✓

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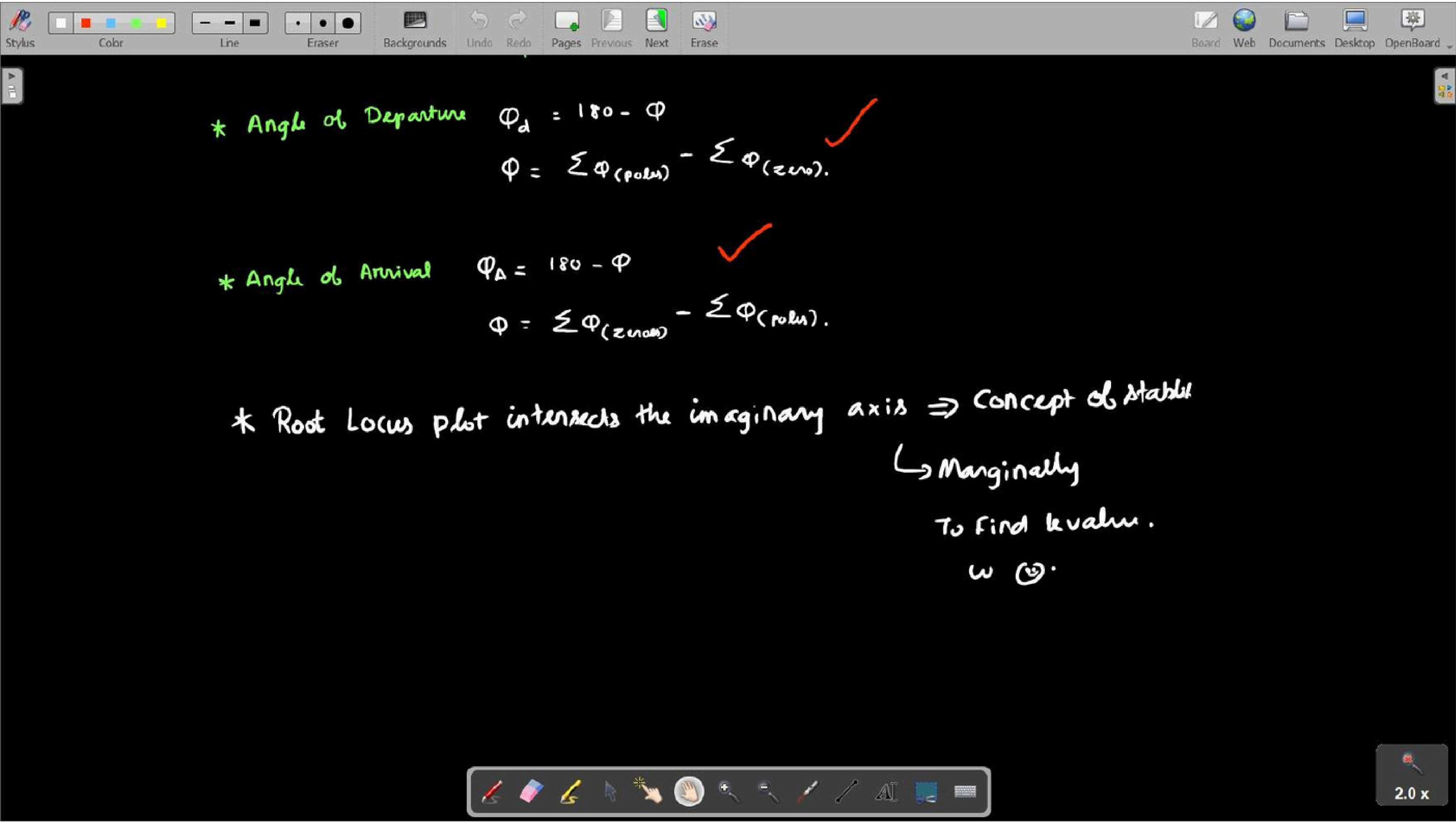


* Angle of Departure $\phi_d = 180 - \phi$

$\phi = \sum \phi_{(poles)} - \sum \phi_{(zero)}$. ✓

* Angle of Arrival $\phi_A = 180 - \phi$ ✓

$\phi = \sum \phi_{(zeros)} - \sum \phi_{(poles)}$.

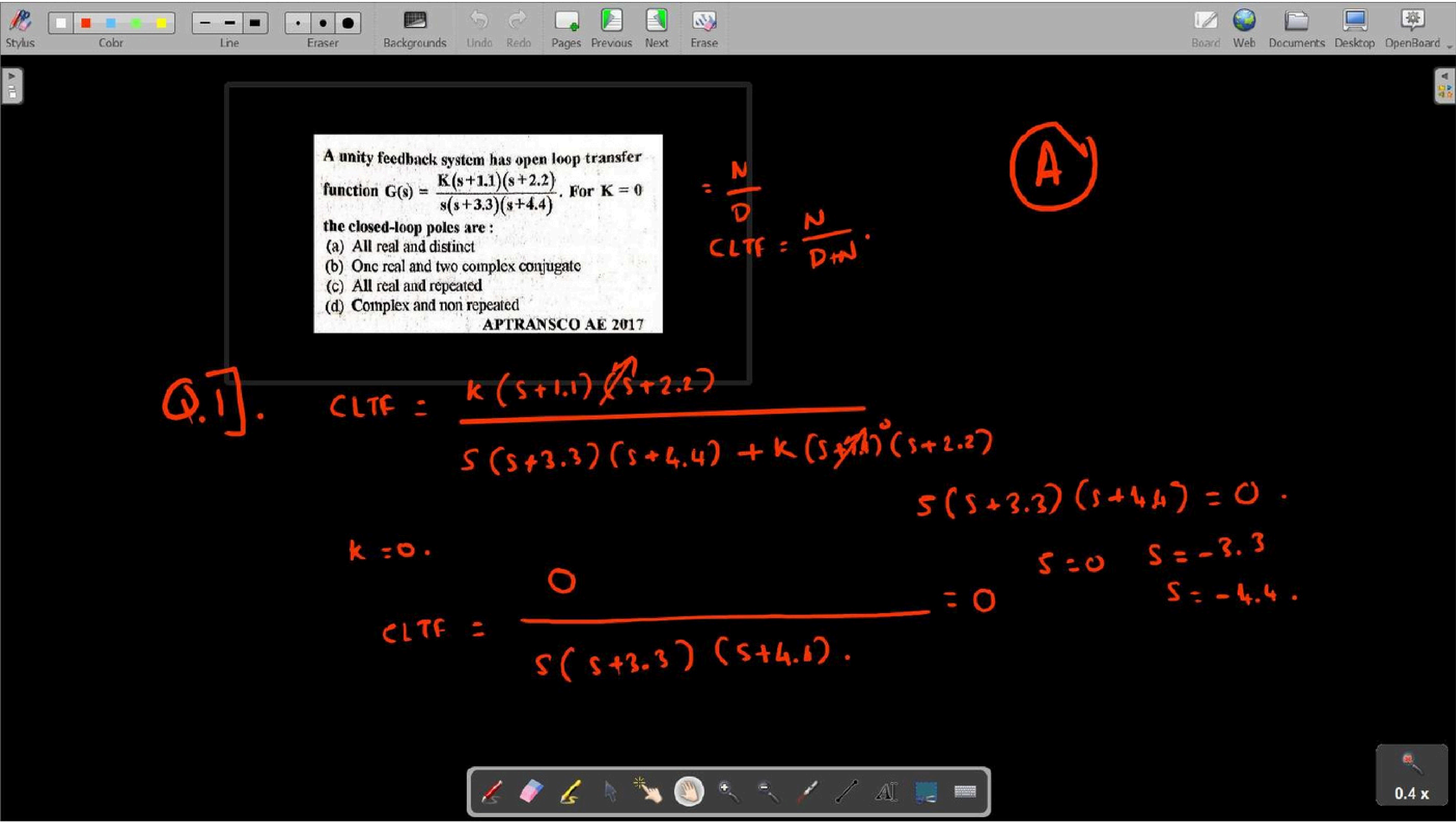
* Root Locus plot intersects the imaginary axis ⇒ Concept of stabili

↳ Marginally

To find k value.

ω ☺.

Full Video Link



A unity feedback system has open loop transfer function $G(s) = \frac{K(s+1.1)(s+2.2)}{s(s+3.3)(s+4.4)}$. For K = 0 the closed-loop poles are :

(a) All real and distinct
(b) One real and two complex conjugate
(c) All real and repeated
(d) Complex and non repeated

APTRANSCO AE 2017

$= \frac{N}{D}$

$CLTF = \frac{N}{D+N}.$

Ⓐ

Q.1].

$$CLTF = \frac{k(s+1.1)\cancel{(s+2.2)}}{s(s+3.3)(s+4.4) + k\cancel{(s+1.1)}^{0}(s+2.2)}$$

$s(s+3.3)(s+4.4) = 0.$

$s=0 \quad s=-3.3$
$s=-4.4.$

$k=0.$

$$CLTF = \frac{0}{s(s+3.3)(s+4.4).} = 0$$

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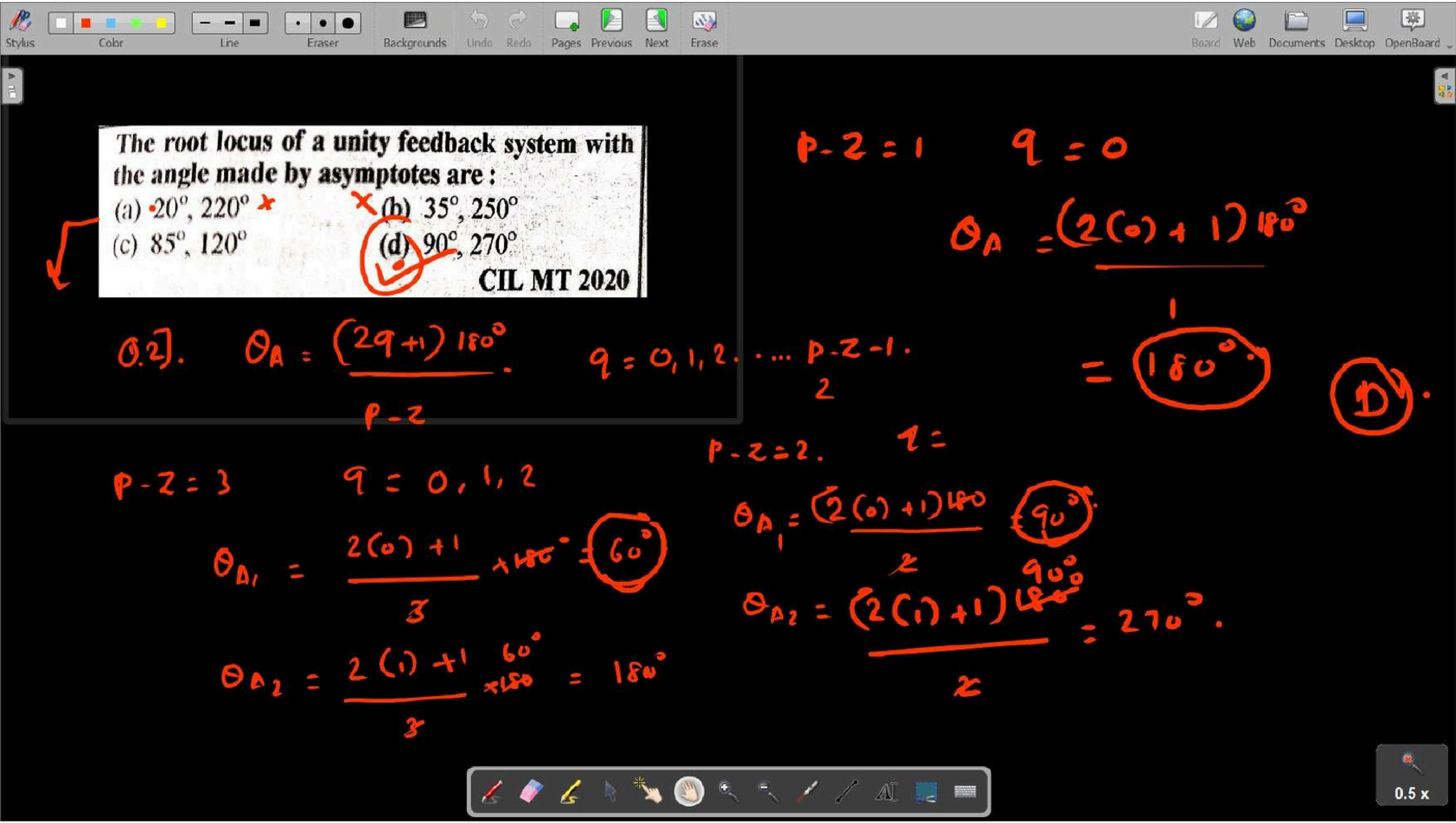


The root locus of a unity feedback system with the angle made by asymptotes are :

(a) 20°, 220° ✗ ✗ (b) 35°, 250°

(c) 85°, 120° [✓ (d) 90°, 270°]

CIL MT 2020

Q.2]. $\theta_A = \frac{(2q+1)\,180°}{P-Z}$. $q = 0, 1, 2 \,.\,.\,.\,.\, \frac{P-Z-1}{2}$.

$P-Z=1$ $q=0$

$\theta_A = \frac{(2(0)+1)\,180°}{1}$

$= \boxed{180°}$

$\boxed{D}$.

$P-Z=3$ $q = 0, 1, 2$

$\theta_{A_1} = \frac{2(0)+1}{3} \times 180° = \boxed{60°}$

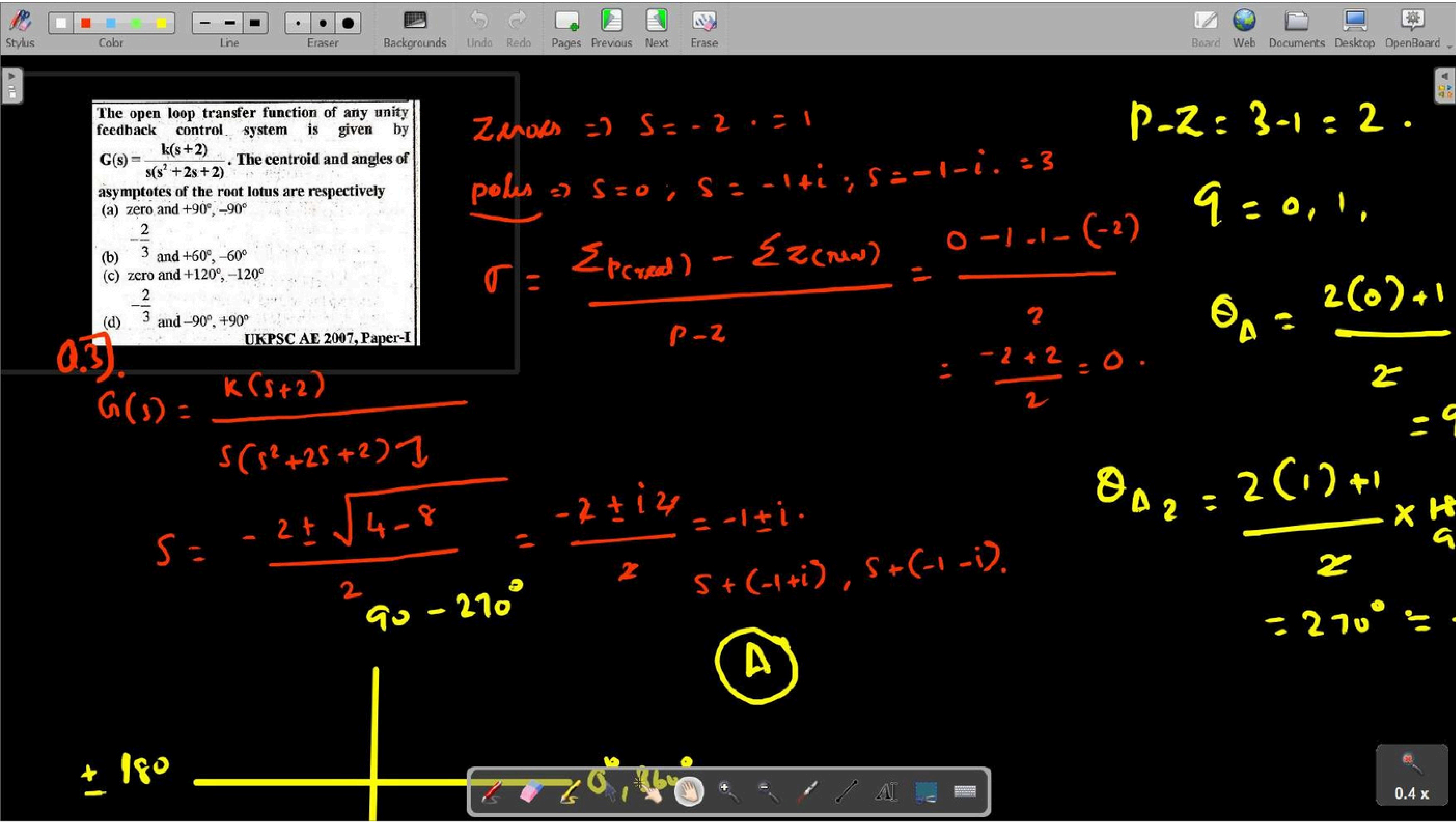
$\theta_{A_2} = \frac{2(1)+1}{3} \overset{60°}{\times 180} = 180°$

$P-Z=2$. $q=$

$\theta_{A_1} = \frac{(2(0)+1)\,180}{2}$ $\boxed{90°}$.

$\theta_{A_2} = \frac{(2(1)+1)\,\overset{90°}{\cancel{180}}}{2} = 270°$.

Full Video Link



The open loop transfer function of any unity feedback control system is given by $G(s) = \frac{k(s+2)}{s(s^2+2s+2)}$. The centroid and angles of asymptotes of the root lotus are respectively

(a) zero and +90°, –90°

(b) $-\frac{2}{3}$ and +60°, –60°

(c) zero and +120°, –120°

(d) $-\frac{2}{3}$ and –90°, +90°

UKPSC AE 2007, Paper-I

Q.3).

$$G(s) = \frac{K(s+2)}{s(s^2+2s+2)}$$

Zeros ⇒ $s = -2 . = 1$

poles ⇒ $s = 0 ; s = -1+i ; s = -1-i . = 3$

$$\sigma = \frac{\Sigma p(real) - \Sigma z(real)}{P-Z} = \frac{0-1-1-(-2)}{2}$$

$$= \frac{-2+2}{2} = 0.$$

$$s = \frac{-2 \pm \sqrt{4-8}}{2} = \frac{-2 \pm i2}{2} = -1 \pm i.$$

$s+(-1+i) , s+(-1-i).$

90 – 270°

P – Z = 3 – 1 = 2.

q = 0, 1,

$$\theta_A = \frac{2(0)+1}{2}$$

= 9

$$\theta_{A2} = \frac{2(1)+1}{2} \times$$

= 270° =

$\boxed{A}$

± 180

0°, 360°

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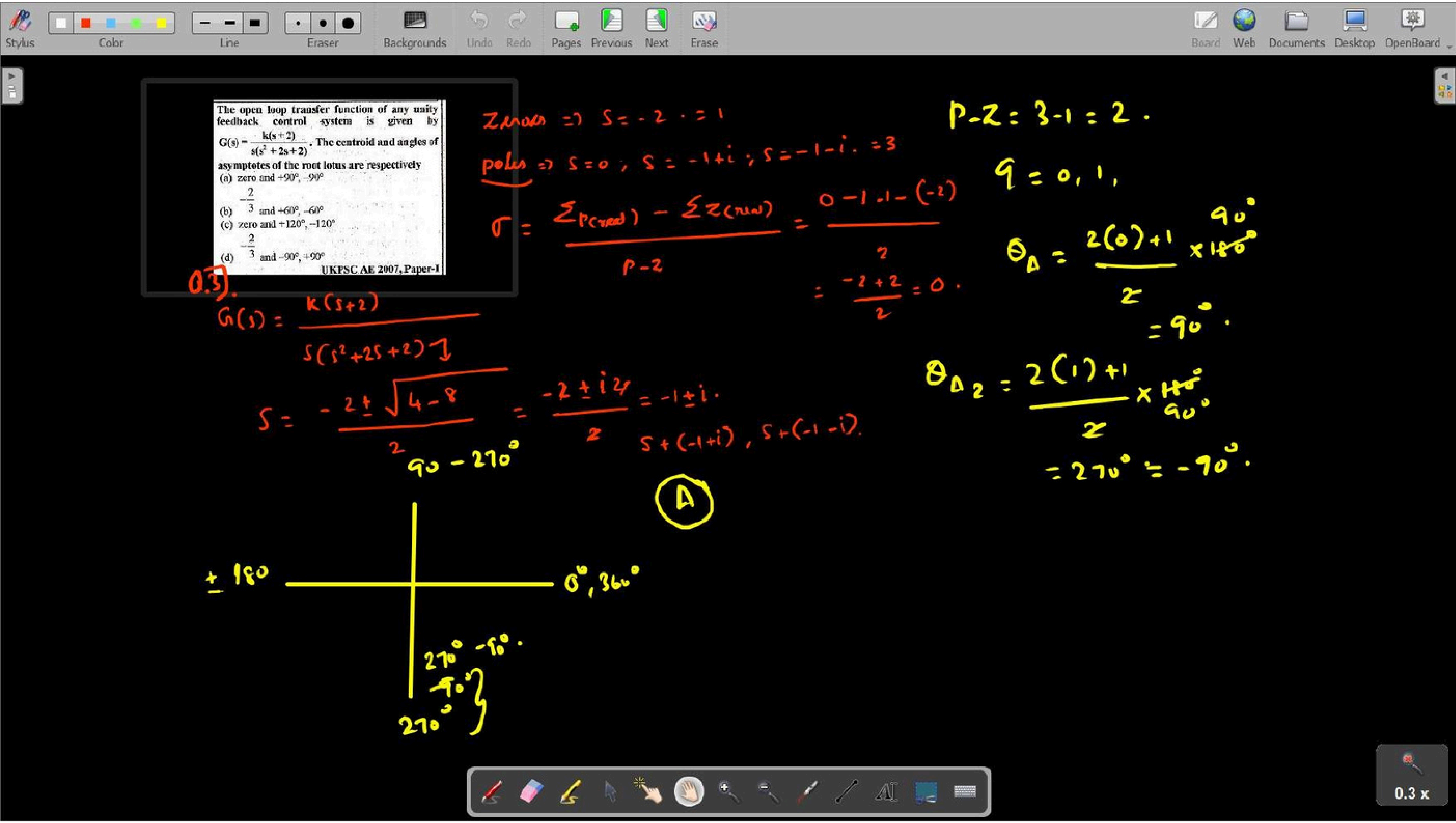


The open loop transfer function of any unity feedback control system is given by $G(s) = \frac{k(s+2)}{s(s^2+2s+2)}$. The centroid and angles of asymptotes of the root lotus are respectively

(a) zero and +90°, −90°

(b) $-\frac{2}{3}$ and +60°, −60°

(c) zero and +120°, −120°

(d) $-\frac{2}{3}$ and −90°, +90°

UKPSC AE 2007, Paper-I

Q.3).

$G(s) = \frac{k(s+2)}{s(s^2+2s+2)]}$

$s = \frac{-2 \pm \sqrt{4-8}}{2} = \frac{-2 \pm i2}{2} = -1 \pm i.$

$s+(-1+i)$, $s+(-1-i)$.

90 − 270°

Zeros ⇒ s = −2 . = 1

poles ⇒ s = 0 ; s = −1+i ; s = −1−i . = 3

$\sigma = \frac{\Sigma p(\text{real}) - \Sigma z(\text{real})}{P-Z} = \frac{0-1-1-(-2)}{2}$

$= \frac{-2+2}{2} = 0.$

P−Z = 3−1 = 2.

q = 0, 1,

$\theta_A = \frac{2(0)+1}{2} \times \overset{90^\circ}{\cancel{180^\circ}}$

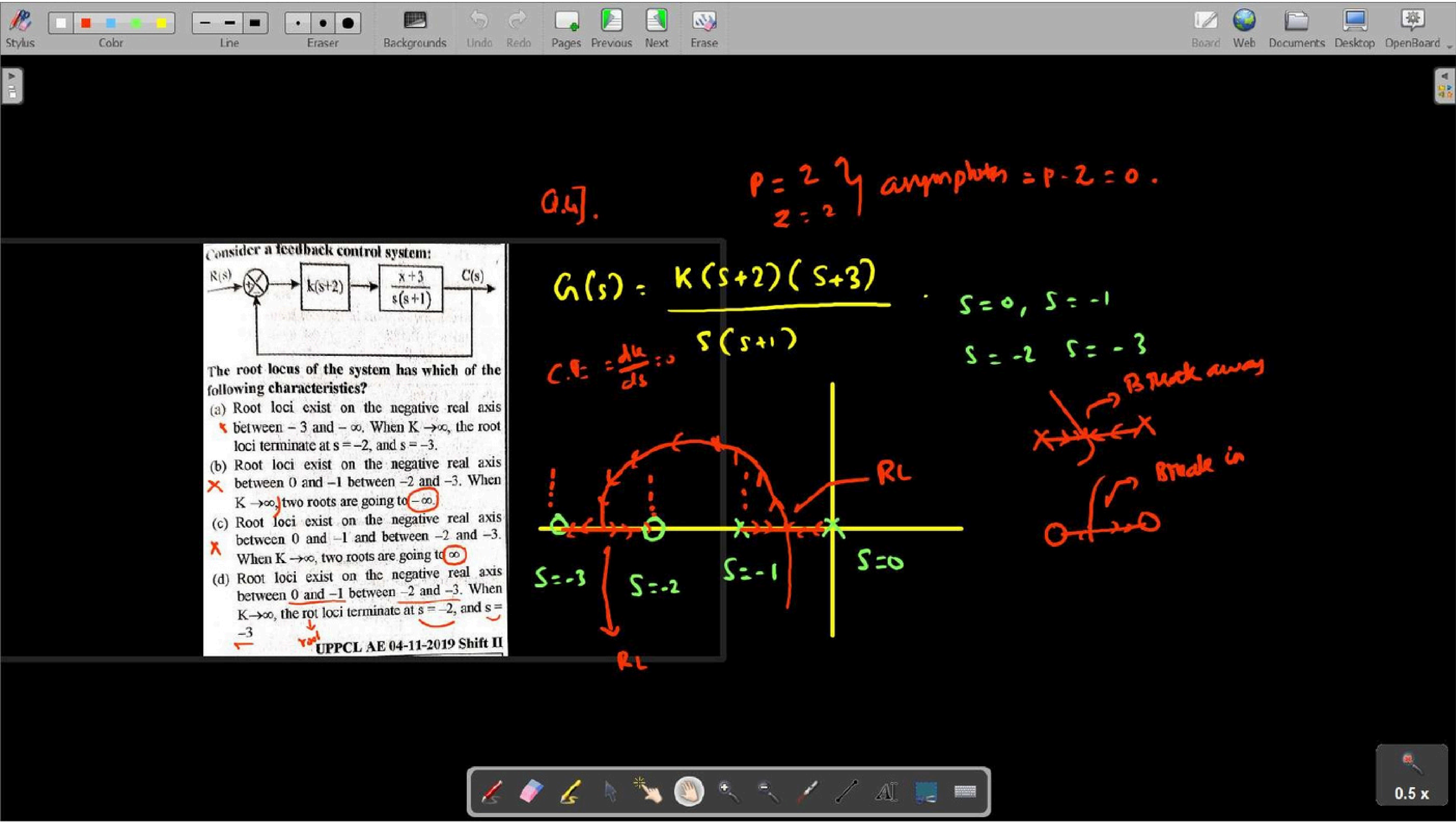
$= 90^\circ.$

$\theta_{A_2} = \frac{2(1)+1}{2} \times \overset{}{\cancel{180^\circ}}\ 90^\circ$

$= 270^\circ = -90^\circ.$

(A)

Full Video Link



Q.4].

P = 2
Z = 2 } asymptotes = P - Z = 0.

$$G(s) = \frac{K(S+2)(S+3)}{S(S+1)}.$$

S = 0, S = -1

S = -2 S = -3

C.E = $\frac{dk}{ds}$ = 0

Consider a feedback control system:

The root locus of the system has which of the following characteristics?

(a) Root loci exist on the negative real axis between – 3 and – ∞. When K →∞, the root loci terminate at s = –2, and s = –3.

(b) Root loci exist on the negative real axis between 0 and –1 between –2 and –3. When K →∞, two roots are going to – ∞.

(c) Root loci exist on the negative real axis between 0 and –1 and between –2 and –3. When K →∞, two roots are going to ∞

(d) Root loci exist on the negative real axis between 0 and –1 between –2 and –3. When K→∞, the rot loci terminate at s = –2, and s = –3

Yes

UPPCL AE 04-11-2019 Shift II

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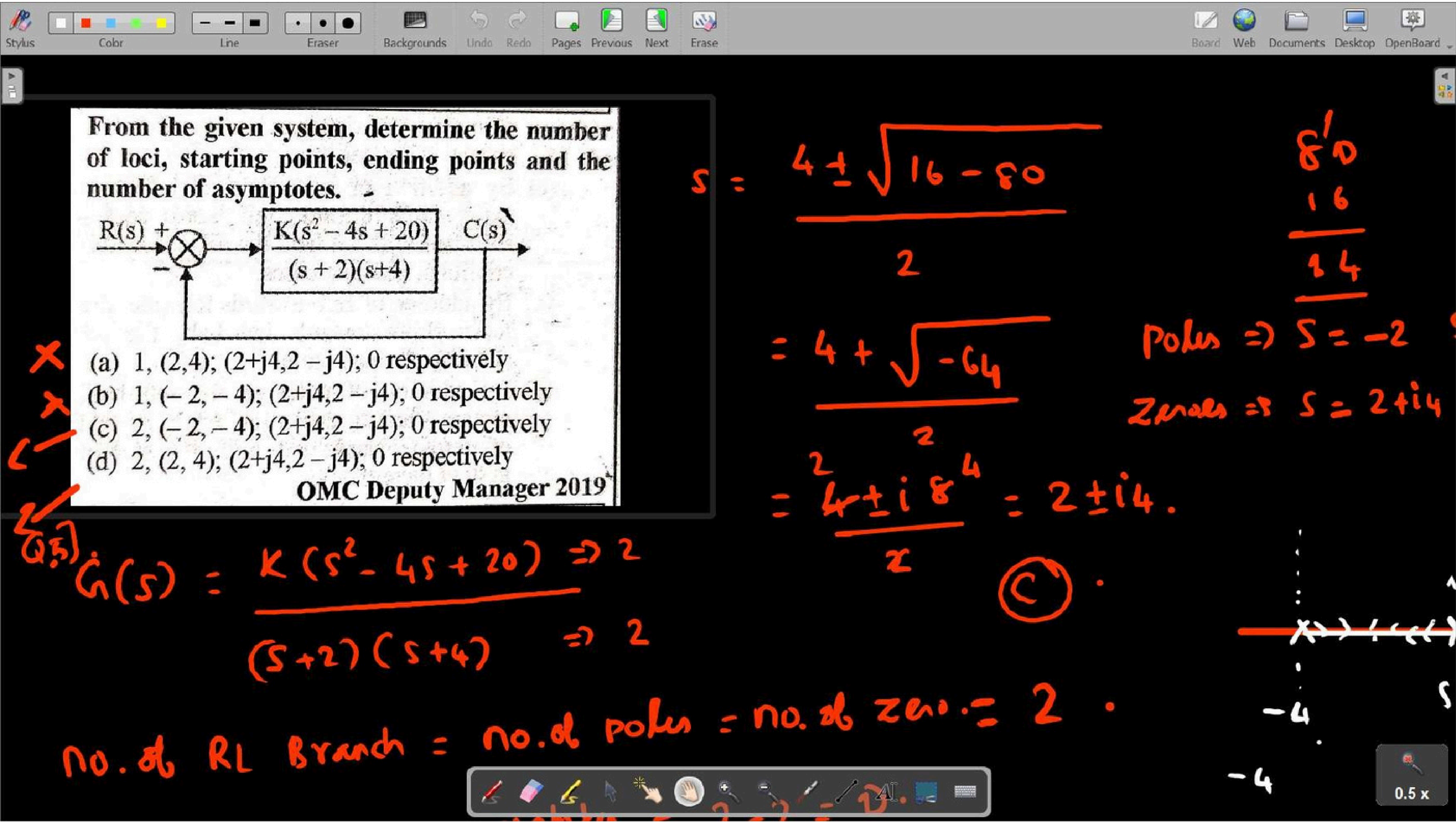


From the given system, determine the number of loci, starting points, ending points and the number of asymptotes.

$$R(s) \to \otimes \to \frac{K(s^2-4s+20)}{(s+2)(s+4)} \to C(s)$$

(a) 1, (2,4); (2+j4,2 – j4); 0 respectively

(b) 1, (– 2, – 4); (2+j4,2 – j4); 0 respectively

(c) 2, (– 2, – 4); (2+j4,2 – j4); 0 respectively

(d) 2, (2, 4); (2+j4,2 – j4); 0 respectively

OMC Deputy Manager 2019

Q.5) $G(s) = \frac{K(s^2-4s+20)}{(s+2)(s+4)}$ ⇒ 2 ⇒ 2

no. of RL Branch = no. of poles = no. of zero = 2.

$$s = \frac{4 \pm \sqrt{16-80}}{2}$$

$$= \frac{4 + \sqrt{-64}}{2}$$

$$= \frac{\cancel{4}^{2} \pm i\,\cancel{8}^{4}}{\cancel{2}} = 2 \pm i4.$$

$\boxed{c}$.

$$\begin{array}{r} 80 \\ 16 \\ \hline 64 \end{array}$$

poles ⇒ s = −2

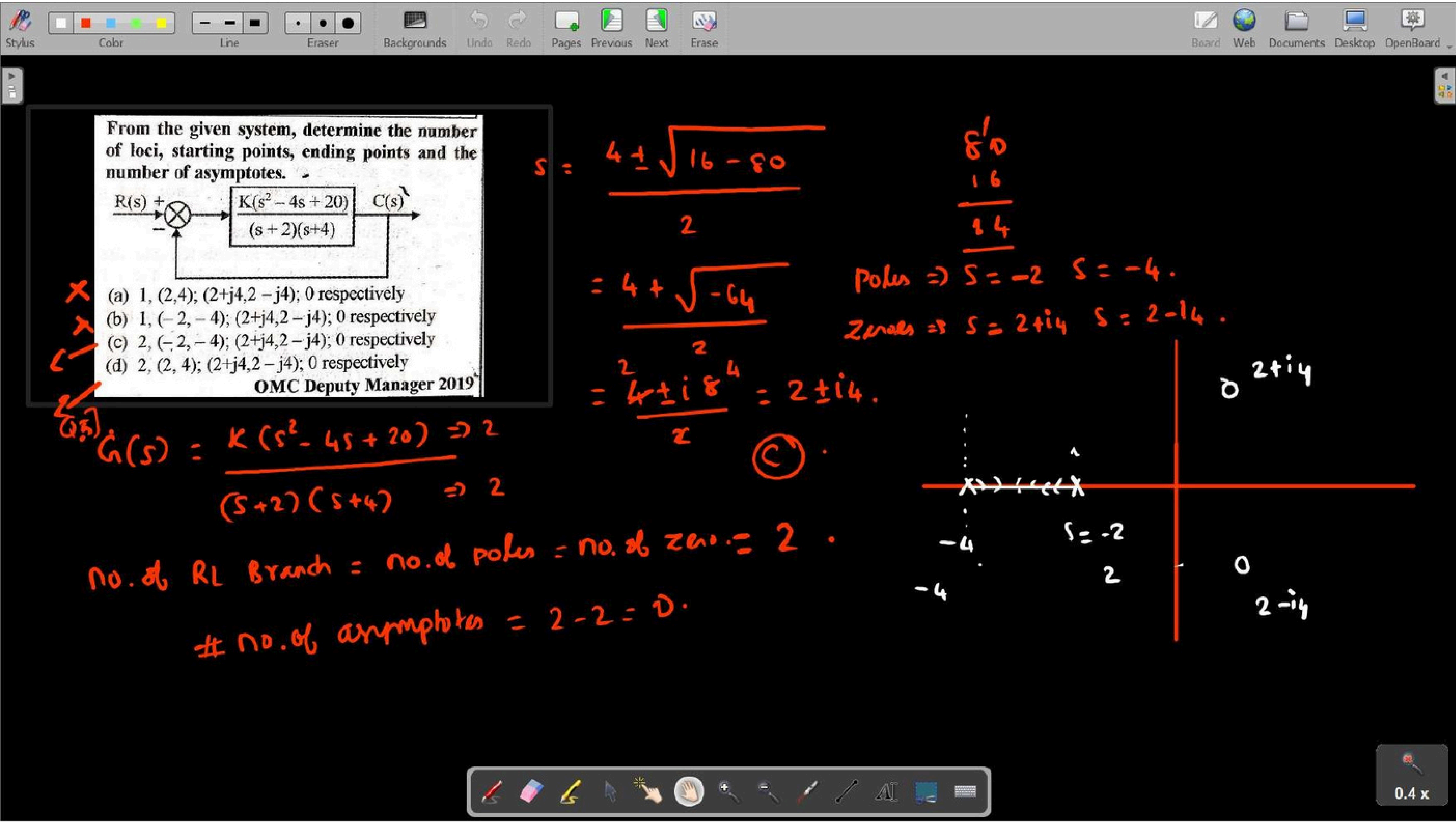
Zeros ⇒ s = 2+i4

−4

−4

s

Full Video Link



From the given system, determine the number of loci, starting points, ending points and the number of asymptotes.

$$\frac{K(s^2-4s+20)}{(s+2)(s+4)}$$

(a) 1, (2,4); (2+j4,2 – j4); 0 respectively

(b) 1, (– 2, – 4); (2+j4,2 – j4); 0 respectively

(c) 2, (– 2, – 4); (2+j4,2 – j4); 0 respectively

(d) 2, (2, 4); (2+j4,2 – j4); 0 respectively

OMC Deputy Manager 2019

Q.5

$$G(s) = \frac{K(s^2-4s+20)}{(s+2)(s+4)} \begin{matrix} \Rightarrow 2 \\ \Rightarrow 2 \end{matrix}$$

$$s = \frac{4 \pm \sqrt{16-80}}{2}$$

$$= \frac{4+\sqrt{-64}}{2}$$

$$= \frac{\overset{2}{4} \pm i\,\overset{4}{8}}{2} = 2 \pm i4.$$

$$\begin{array}{r} 8^{1}0 \\ 16 \\ \hline 64 \\ \hline \end{array}$$

Poles ⇒ s = −2 s = −4.

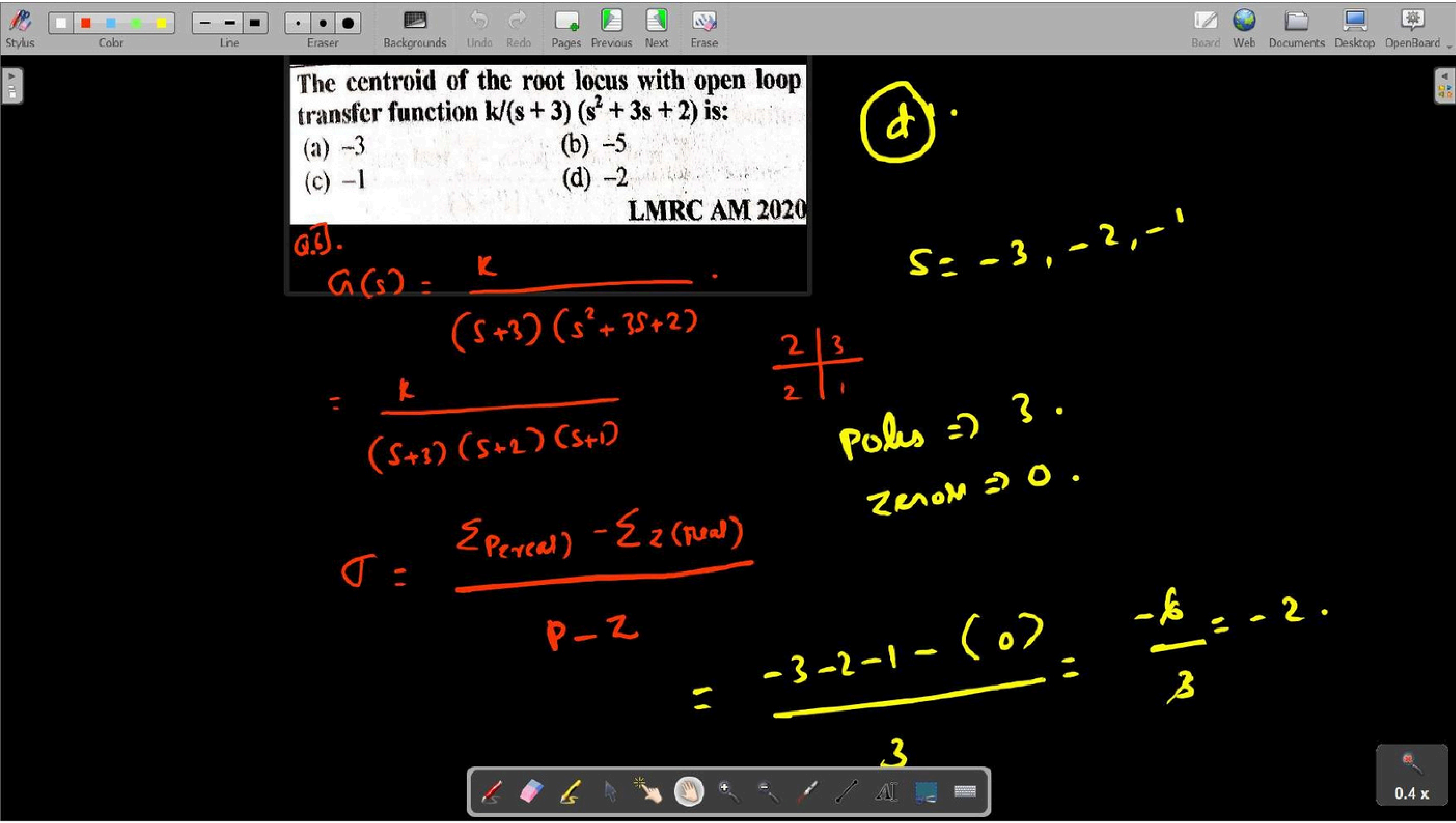
Zeros ⇒ s = 2+i4 s = 2-i4.

Ⓒ.

no. of RL Branch = no. of poles = no. of zero = 2.

no. of asymptotes = 2 - 2 = 0.

Full Video Link



The centroid of the root locus with open loop transfer function k/(s + 3) $(s^2 + 3s + 2)$ is:

(a) –3 (b) –5

(c) –1 (d) –2

LMRC AM 2020

Q.6].

$$G(s) = \frac{K}{(s+3)(s^2+3s+2)} .$$

$$= \frac{K}{(s+3)(s+2)(s+1)}$$

$$\sigma = \frac{\sum P_{(real)} - \sum Z_{(real)}}{P-Z}$$

$$= \frac{-3-2-1-(0)}{3} = \frac{-\cancel{6}}{\cancel{3}} = -2 .$$

$\boxed{d}$.

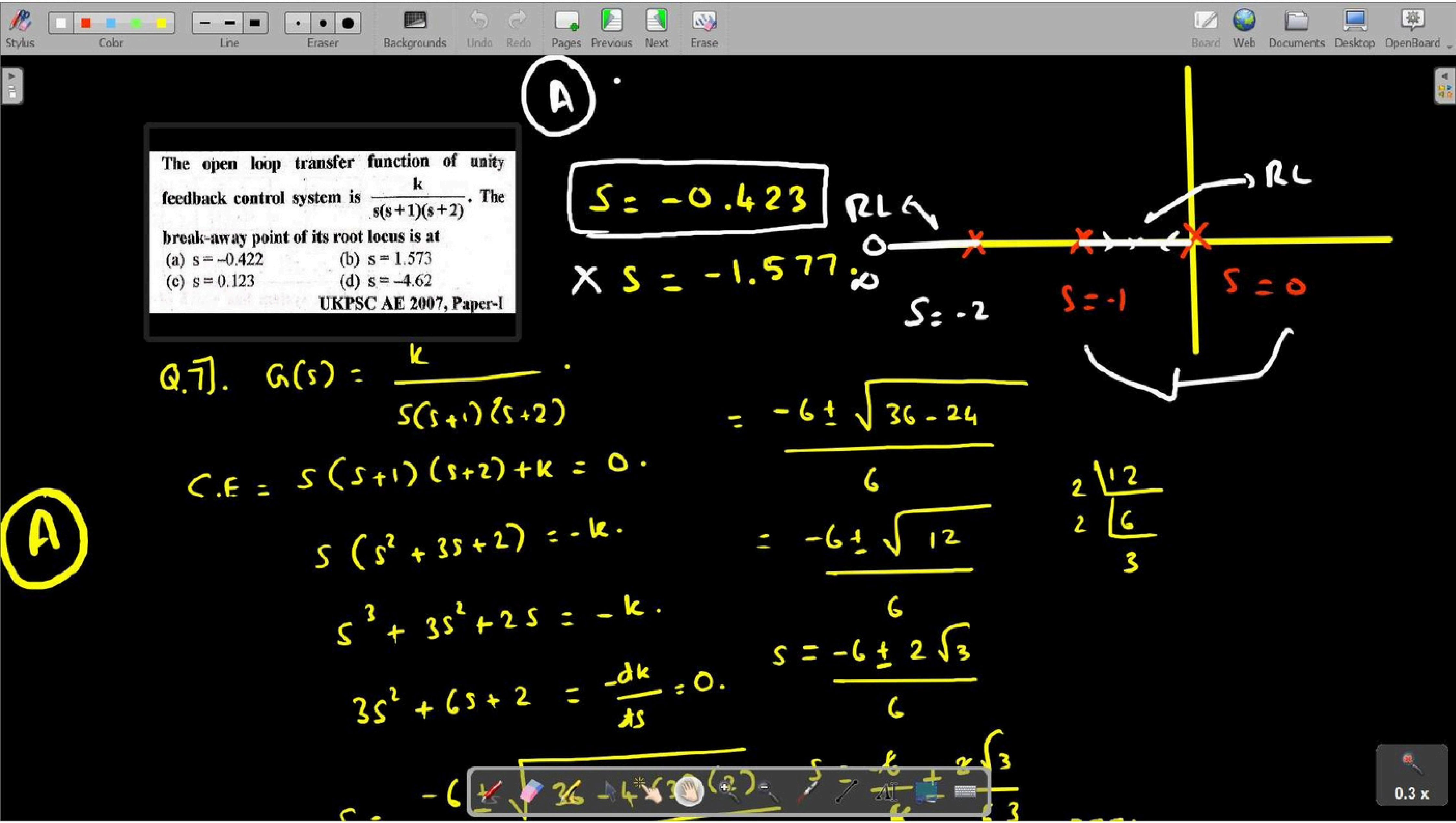
$s = -3, -2, -1$

$$\begin{array}{c|c} 2 & 3 \\ \hline 2 & 1 \end{array}$$

Poles ⇒ 3 .

Zeros ⇒ 0 .

Full Video Link



The open loop transfer function of unity feedback control system is $\frac{k}{s(s+1)(s+2)}$. The break-away point of its root locus is at

(a) s = −0.422 (b) s = 1.573

(c) s = 0.123 (d) s = −4.62

UKPSC AE 2007, Paper-I

Ⓐ

$\boxed{S = -0.423}$

$\times\ S = -1.577 : \infty$

Q.7]. $G(s) = \frac{k}{s(s+1)(s+2)}$.

$C.E = s(s+1)(s+2) + k = 0.$

$s(s^2 + 3s + 2) = -k.$

$s^3 + 3s^2 + 2s = -k.$

$3s^2 + 6s + 2 = \frac{-dk}{ds} = 0.$

$= \frac{-6 \pm \sqrt{36 - 24}}{6}$

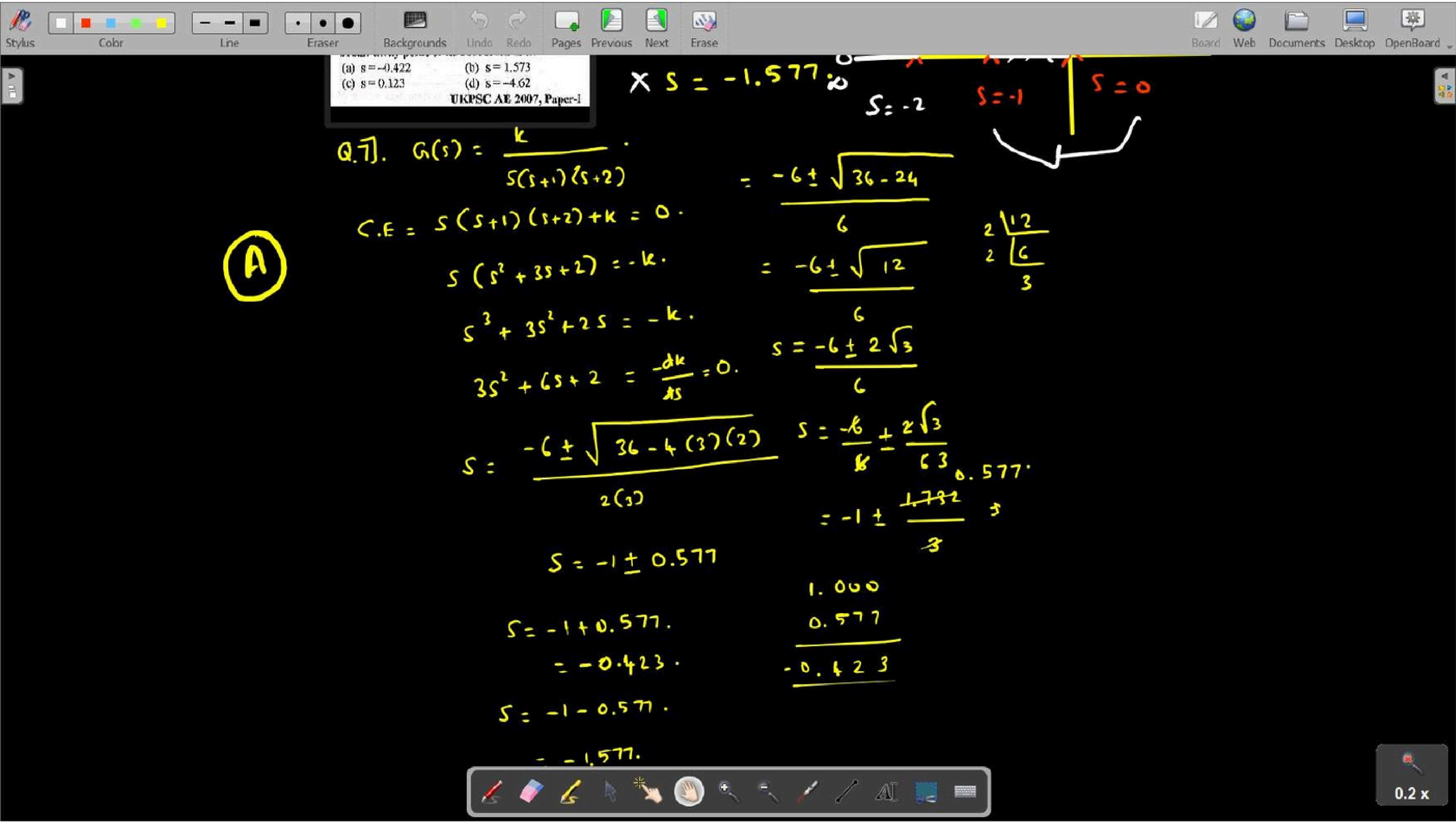
$= \frac{-6 \pm \sqrt{12}}{6}$

$s = \frac{-6 \pm 2\sqrt{3}}{6}$

$$\begin{array}{r|l} 2 & 12 \\ 2 & 6 \\ & 3 \end{array}$$

Ⓐ

Full Video Link



(a) s = −0.422 (b) s = 1.573
(c) s = 0.123 (d) s = −4.62
UKPSC AE 2007, Paper-I

× $S = -1.577$

$S = -2$ $S = -1$ $S = 0$

Ⓐ

Q.7]. $G(s) = \frac{k}{s(s+1)(s+2)}$.

C.E = $s(s+1)(s+2) + k = 0$.

$s(s^2 + 3s + 2) = -k$.

$s^3 + 3s^2 + 2s = -k$.

$3s^2 + 6s + 2 = \frac{-dk}{ds} = 0$.

$S = \frac{-6 \pm \sqrt{36 - 4(3)(2)}}{2(3)}$

$= \frac{-6 \pm \sqrt{36-24}}{6}$

$= \frac{-6 \pm \sqrt{12}}{6}$

$2 \underline{|12}$
$2 \underline{|6}$
3

$s = \frac{-6 \pm 2\sqrt{3}}{6}$

$s = \frac{-\cancel{6}}{\cancel{6}} \pm \frac{\cancel{2}\sqrt{3}}{\cancel{6}\,3}$ 0.577

$= -1 \pm \frac{\cancel{1.732}}{\cancel{3}}$

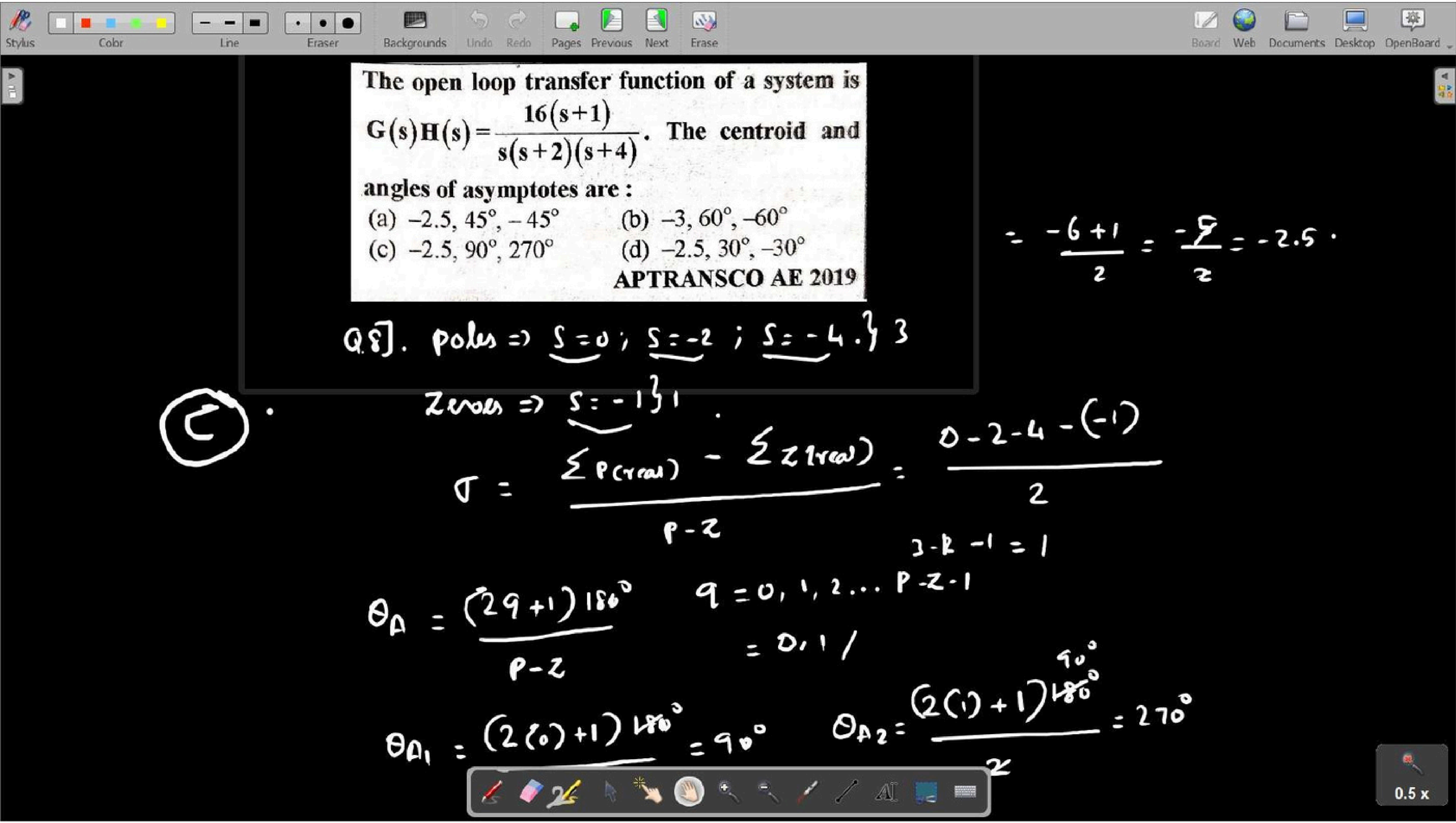
$S = -1 \pm 0.577$

$S = -1 + 0.577$.
$= -0.423$.

$$\begin{array}{r} 1.000 \\ 0.577 \\ \hline -0.423 \\ \hline \end{array}$$

$S = -1 - 0.577$.

$= -1.577$.



The open loop transfer function of a system is $G(s)H(s)=\frac{16(s+1)}{s(s+2)(s+4)}$. The centroid and angles of asymptotes are :

(a) –2.5, 45°, – 45°
(b) –3, 60°, –60°
(c) –2.5, 90°, 270°
(d) –2.5, 30°, –30°

APTRANSCO AE 2019

Q.8]. poles ⇒ $\underbrace{S=0}$; $\underbrace{S=-2}$; $\underbrace{S=-4}$.} 3

Zeros ⇒ $\underbrace{S=-1}$} 1.

$\textcircled{c}$.

$$\sigma = \frac{\sum P(\text{real}) - \sum Z(\text{real})}{P-Z} = \frac{0-2-4-(-1)}{2} = \frac{-6+1}{2} = \frac{-5}{2} = -2.5.$$

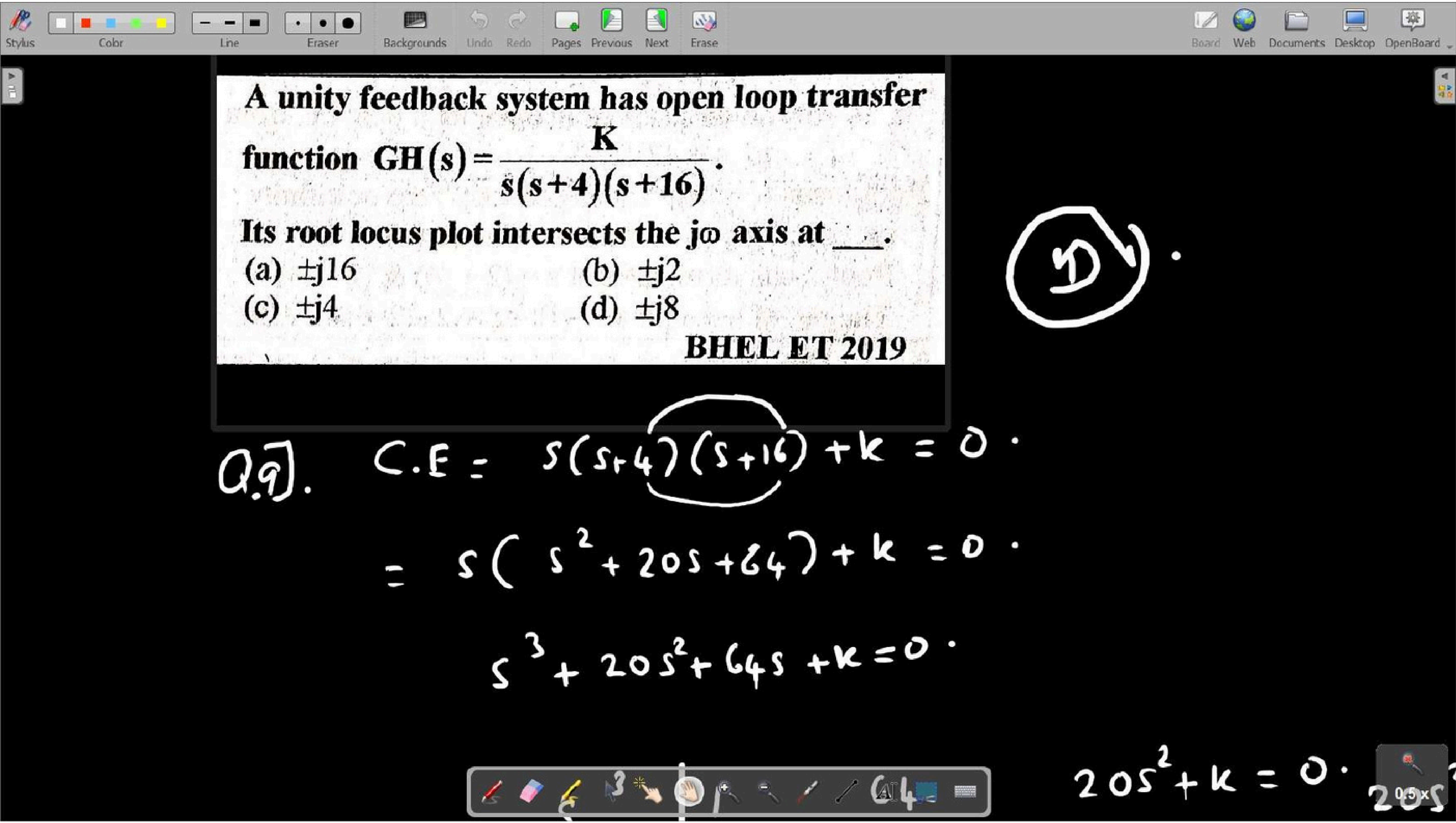
3-1 -1 = 1

$$\theta_A = \frac{(2q+1)180^\circ}{P-Z} \qquad q = 0, 1, 2 \ldots P-Z-1$$

$= 0, 1$ /

$$\theta_{A_1} = \frac{(2(0)+1)180^\circ}{2} = 90^\circ \qquad \theta_{A_2} = \frac{(2(1)+1)\overset{90^\circ}{180^\circ}}{2} = 270^\circ$$

Full Video Link



A unity feedback system has open loop transfer function $GH(s) = \frac{K}{s(s+4)(s+16)}$.

Its root locus plot intersects the jω axis at ___.

(a) ±j16
(b) ±j2
(c) ±j4
(d) ±j8

BHEL ET 2019

$\boxed{D}$.

Q.9].

$$C.E = s(s+4)(s+16) + k = 0.$$

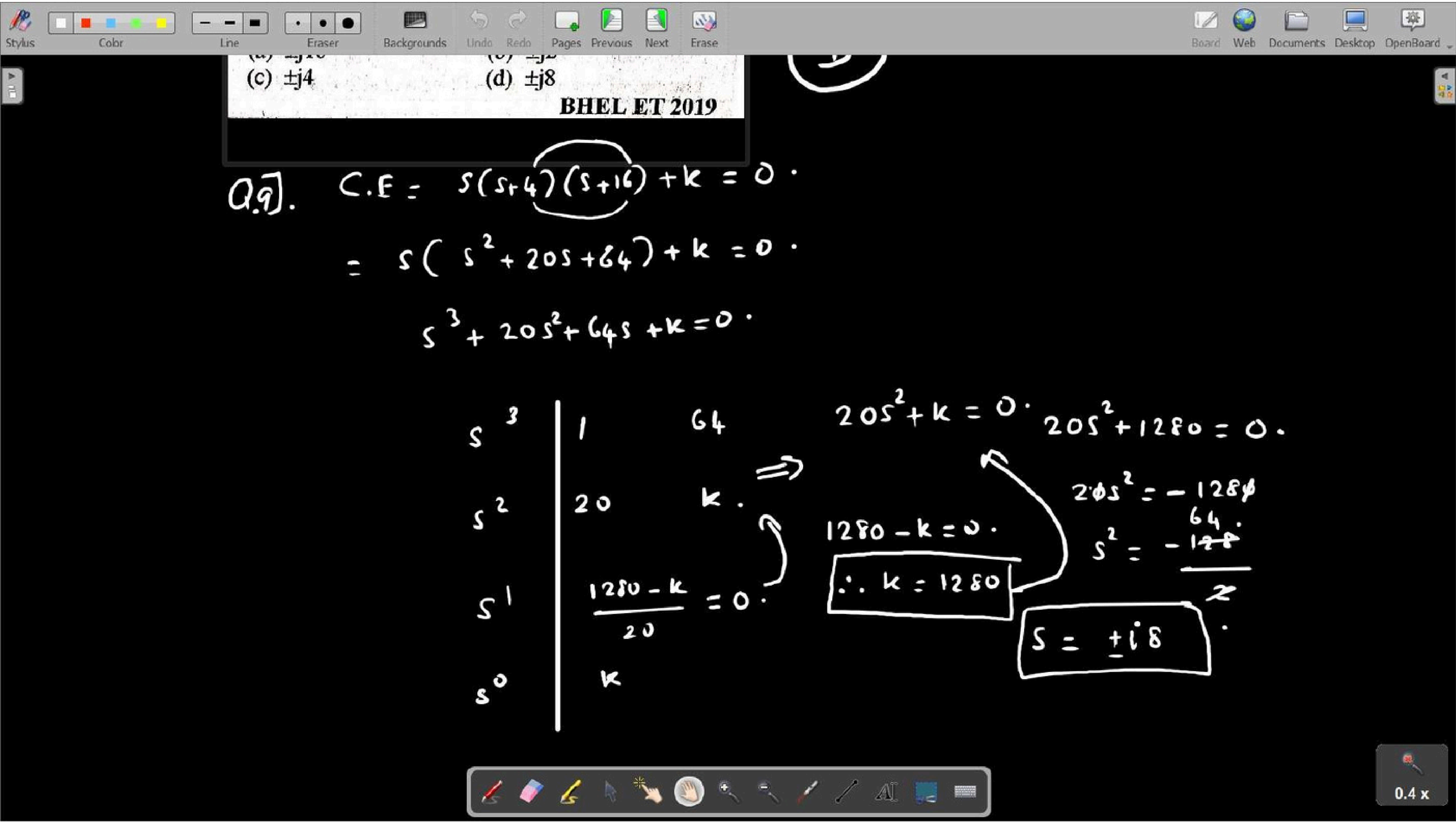
$$= s(s^2 + 20s + 64) + k = 0.$$

$$s^3 + 20s^2 + 64s + k = 0.$$

$$20s^2 + k = 0.$$

$20s$

Full Video Link



(c) ±j4 (d) ±j8

BHEL ET 2019

Q.9].

$$C.E = s(s+4)(s+16) + k = 0.$$

$$= s(s^2 + 20s + 64) + k = 0.$$

$$s^3 + 20s^2 + 64s + k = 0.$$

s^3	1	64
s^2	20	k.
s^1	$\frac{1280-k}{20} = 0.$	
s^0	k	

$$1280 - k = 0.$$

$$\boxed{\therefore k = 1280}$$

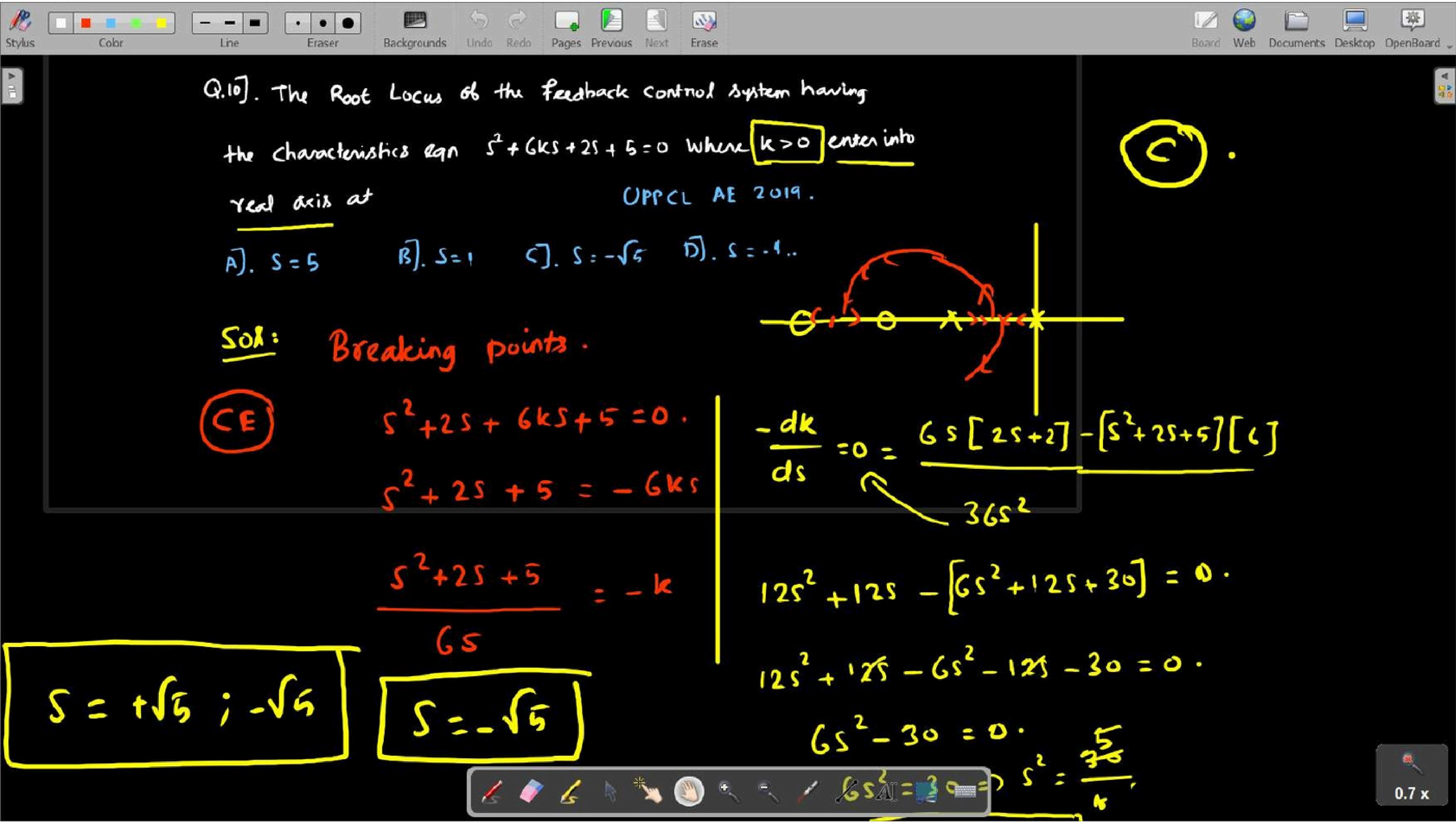
$$20s^2 + k = 0. \quad 20s^2 + 1280 = 0.$$

$$2\cancel{0}s^2 = -128\cancel{0}$$

$$s^2 = -\frac{\overset{64}{\cancel{128}}}{\cancel{2}}.$$

$$\boxed{S = \pm j8}$$

Full Video Link



Q.10]. The Root Locus of the feedback control system having the characteristics eqn $s^2+6Ks+2s+5=0$ where $\boxed{k>0}$ enter into real axis at

UPPCL AE 2019.

A). $s=5$ B]. $s=1$ C]. $s=-\sqrt{5}$ D]. $s=-1..$

$\boxed{C}$.

Sol: Breaking points.

$\boxed{CE}$ $s^2+2s+6ks+5=0$.

$s^2+2s+5=-6ks$

$\frac{s^2+2s+5}{6s}=-k$

$-\frac{dk}{ds}=0=\frac{6s[2s+2]-[s^2+2s+5][6]}{36s^2}$

$12s^2+12s-[6s^2+12s+30]=0$.

$12s^2+\cancel{12s}-6s^2-\cancel{12s}-30=0$.

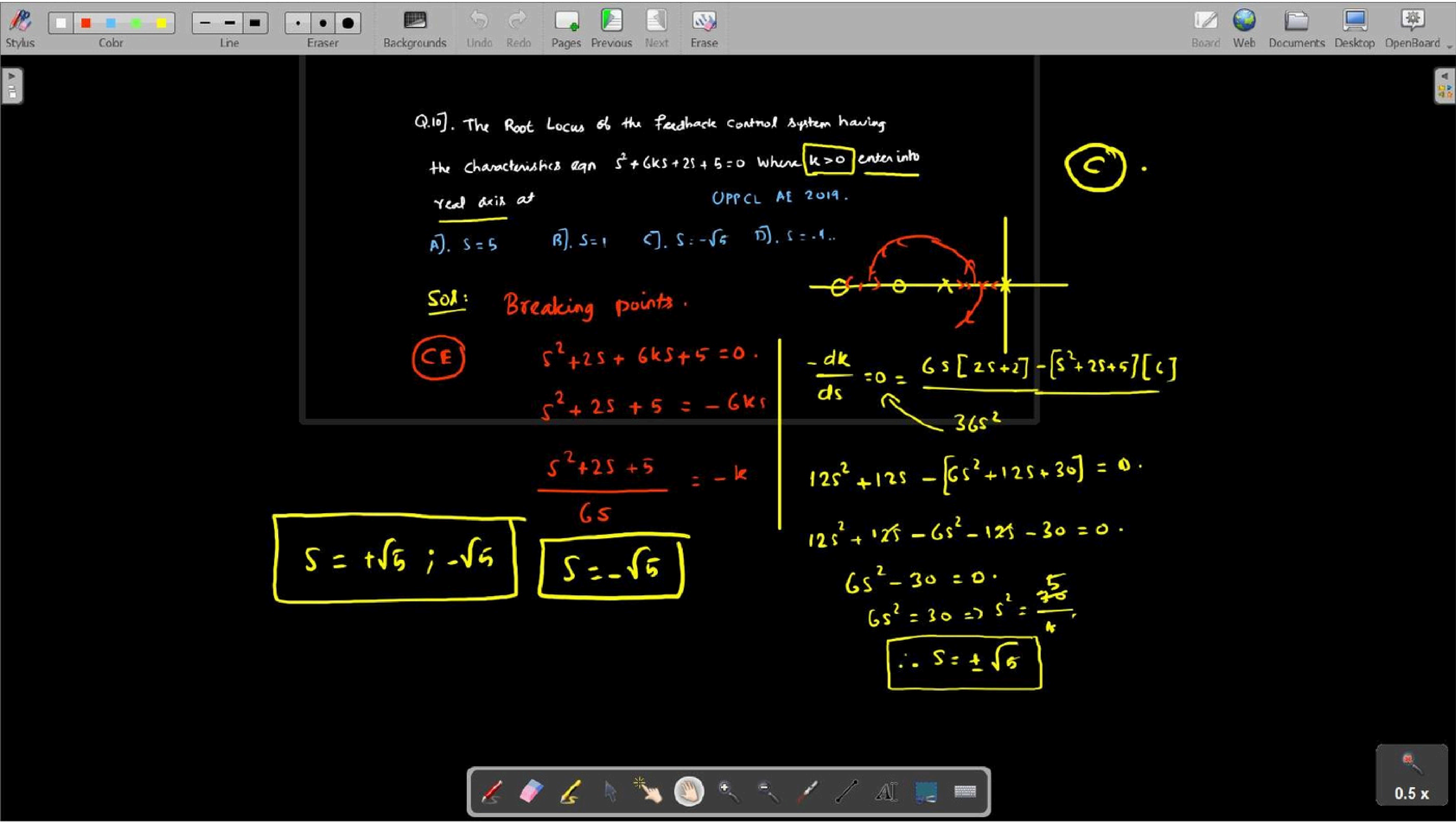
$6s^2-30=0$.

$\Rightarrow s^2=\frac{\cancel{30}\,5}{\cancel{6}}$

$\boxed{s=+\sqrt{5}\ ;\ -\sqrt{5}}$

$\boxed{s=-\sqrt{5}}$

Full Video Link



Q.10]. The Root Locus of the feedback control system having the characteristics eqn $s^2+6ks+2s+5=0$ where $\boxed{k>0}$ enter into real axis at

UPPCL AE 2019.

A). $s=5$ B). $s=1$ C]. $s=-\sqrt{5}$ D). $s=.1..$

$\bigcirc\!\!\!\!\text{C}$.

Sol: Breaking points.

(CE)

$$s^2+2s+6ks+5=0.$$

$$s^2+2s+5=-6ks$$

$$\frac{s^2+2s+5}{6s}=-k$$

$$\boxed{s=+\sqrt{5}\ ;\ -\sqrt{5}}\quad \boxed{s=-\sqrt{5}}$$

$$-\frac{dk}{ds}=0=\frac{6s[2s+2]-[s^2+2s+5][6]}{36s^2}$$

$$12s^2+12s-[6s^2+12s+30]=0.$$

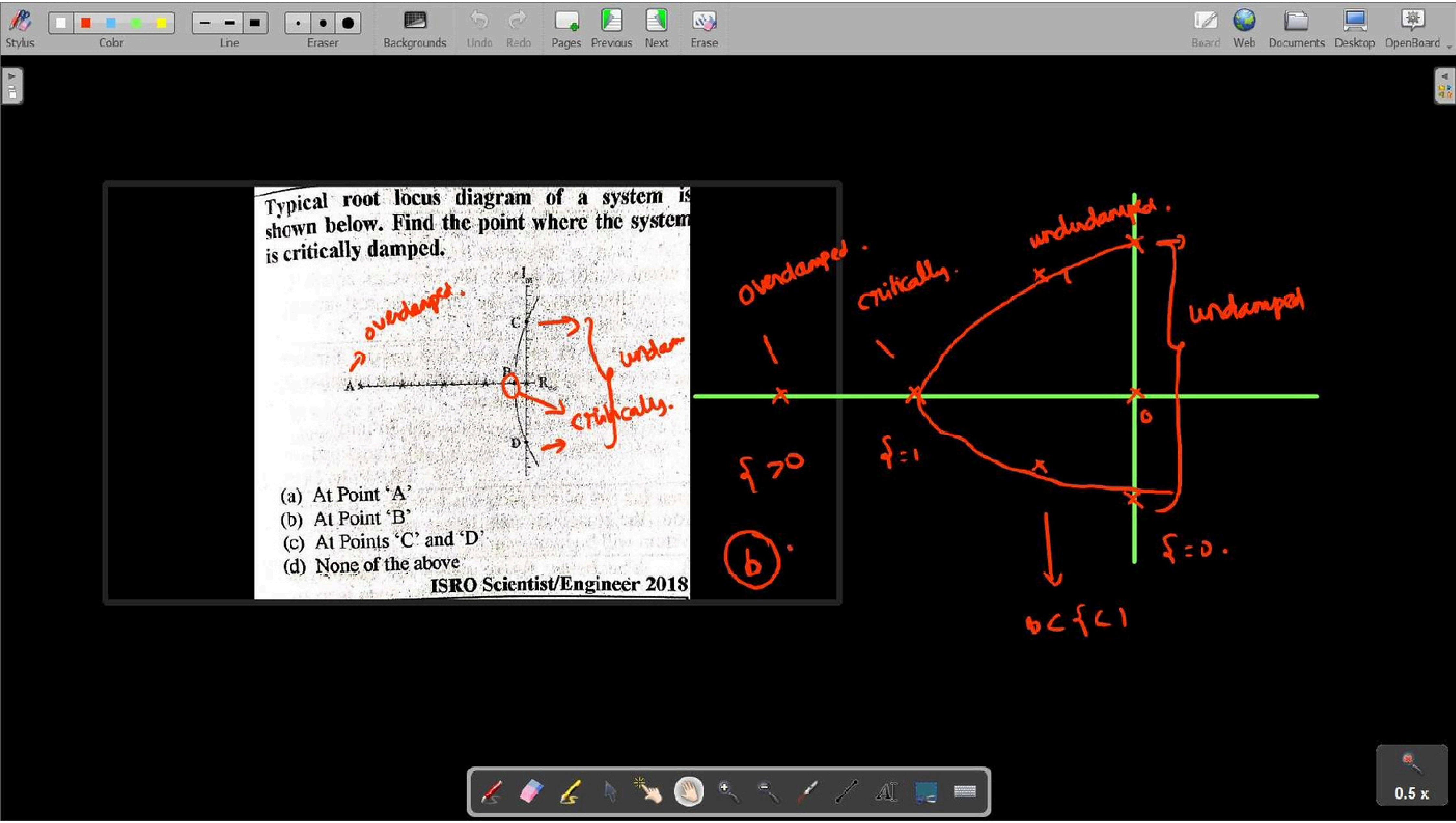
$$12s^2+\cancel{12s}-6s^2-\cancel{12s}-30=0.$$

$$6s^2-30=0.$$

$$6s^2=30\Rightarrow s^2=\frac{\cancel{30}^{5}}{\cancel{6}}$$

$$\boxed{\therefore s=\pm\sqrt{5}}$$

Full Video Link

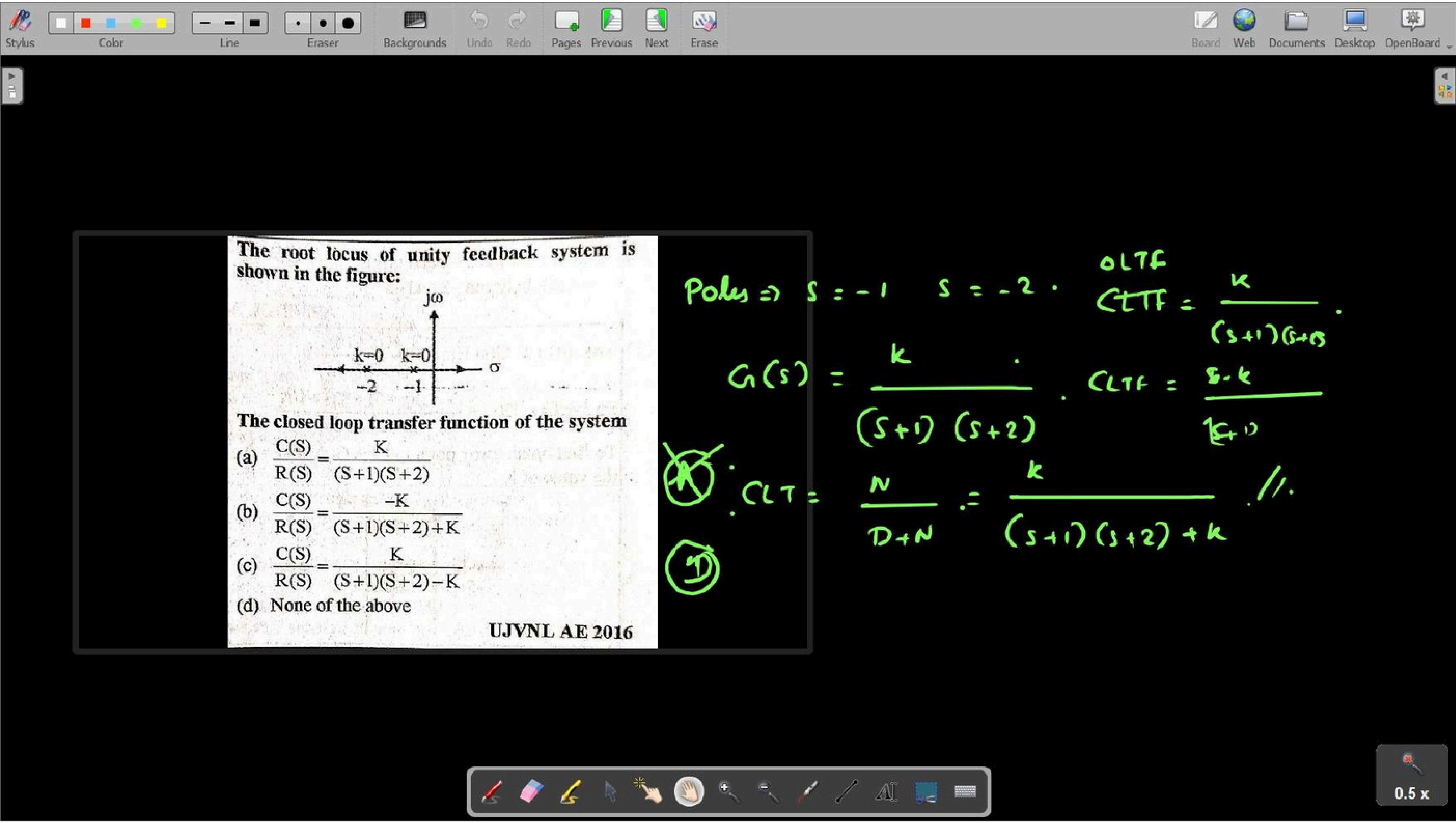


Typical root locus diagram of a system is shown below. Find the point where the system is critically damped.

(a) At Point 'A'
(b) At Point 'B'
(c) At Points 'C' and 'D'
(d) None of the above

ISRO Scientist/Engineer 2018

Full Video Link



The root locus of unity feedback system is shown in the figure:

The closed loop transfer function of the system

(a) $\frac{C(S)}{R(S)} = \frac{K}{(S+1)(S+2)}$

(b) $\frac{C(S)}{R(S)} = \frac{-K}{(S+1)(S+2)+K}$

(c) $\frac{C(S)}{R(S)} = \frac{K}{(S+1)(S+2)-K}$

(d) None of the above

UJVNL AE 2016

Poles ⇒ $s = -1$ $s = -2$.

OLTF

$\text{CLTF} = \frac{k}{(s+1)(s+2)}$.

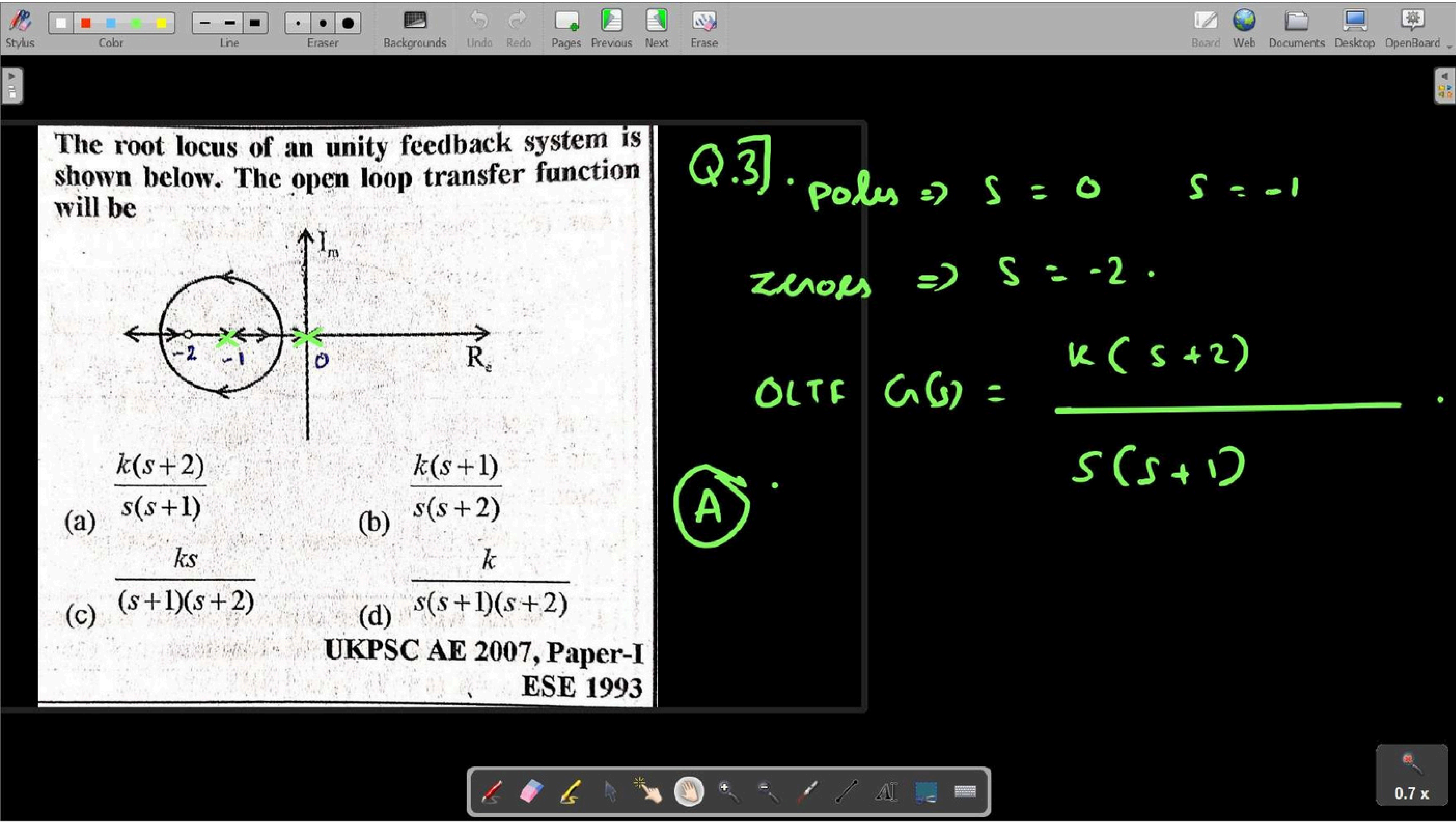
$G(s) = \frac{k}{(s+1)(s+2)}$.

$\text{CLTF} = \frac{G.k}{1+G}$

$\cancel{(A)}$: $\text{CLT} = \frac{N}{D+N} = \frac{k}{(s+1)(s+2)+k}$ //.

(D)

Full Video Link



The root locus of an unity feedback system is shown below. The open loop transfer function will be

(a) $\frac{k(s+2)}{s(s+1)}$

(b) $\frac{k(s+1)}{s(s+2)}$

(c) $\frac{ks}{(s+1)(s+2)}$

(d) $\frac{k}{s(s+1)(s+2)}$

UKPSC AE 2007, Paper-I

ESE 1993

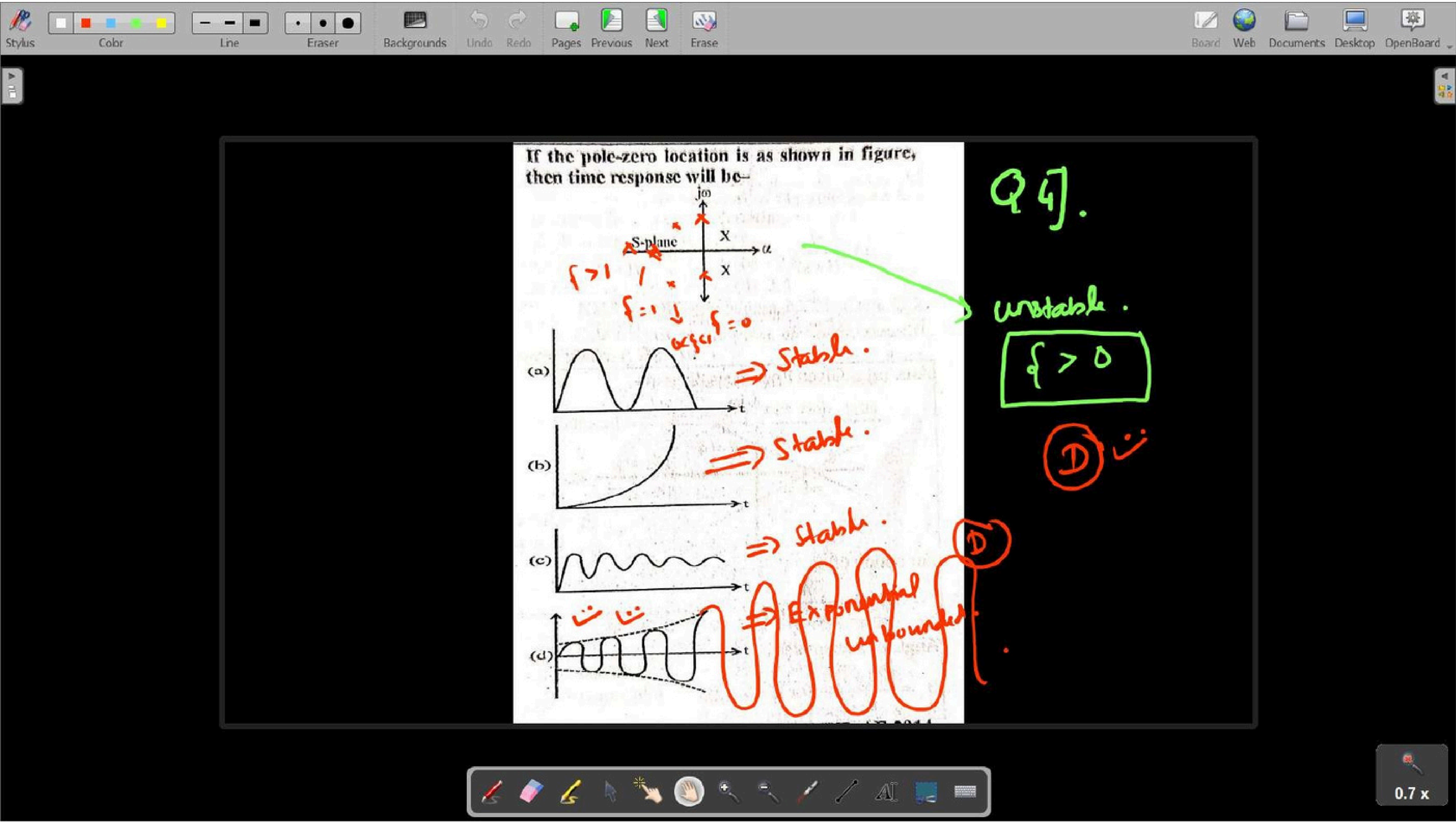
Q.3]. poles ⇒ $s = 0$ $s = -1$

zeros ⇒ $s = -2$.

OLTF $G(s) = \frac{K(s+2)}{s(s+1)}$.

Ⓐ.

Full Video Link



If the pole-zero location is as shown in figure, then time response will be–

Q 4].

ξ>1

ξ=1

ξ=0

0<ξ<1

(a) ⇒ Stable.

(b) ⇒ Stable.

(c) ⇒ Stable.

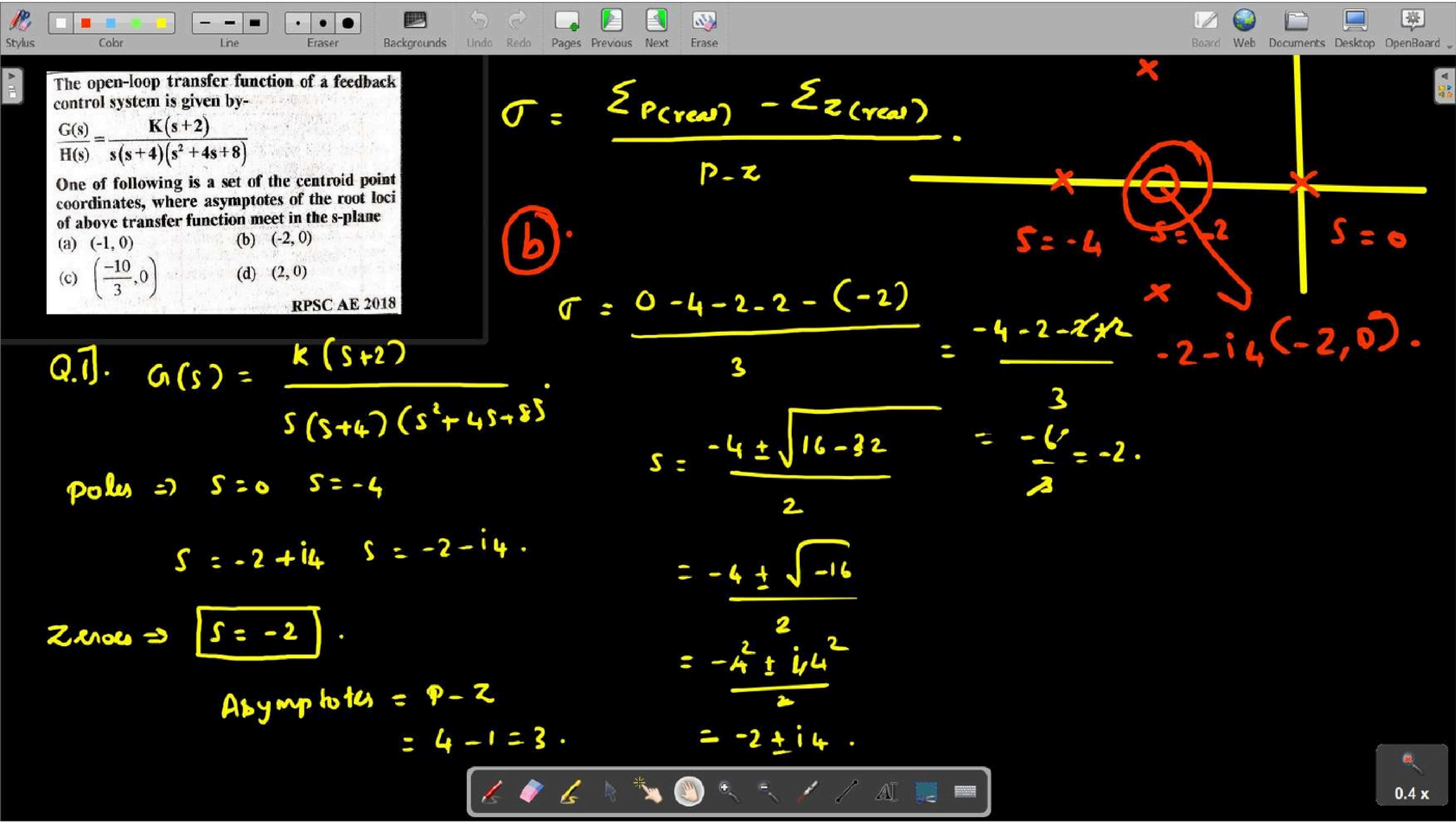
(d) ⇒ Exponential unbounded.

unstable.

$\boxed{\xi > 0}$

(D)

Full Video Link



The open-loop transfer function of a feedback control system is given by-

$$\frac{G(s)}{H(s)} = \frac{K(s+2)}{s(s+4)(s^2+4s+8)}$$

One of following is a set of the centroid point coordinates, where asymptotes of the root loci of above transfer function meet in the s-plane

(a) (-1, 0) (b) (-2, 0)

(c) $\left(\frac{-10}{3}, 0\right)$ (d) (2, 0)

RPSC AE 2018

Q.1]. $G(s) = \frac{k(s+2)}{s(s+4)(s^2+4s+8)}$.

poles => $s=0$ $s=-4$

$s = -2+i4$ $s = -2-i4$.

Zeros => $\boxed{s=-2}$.

Asymptotes = P - Z

= 4 - 1 = 3.

$$\sigma = \frac{\Sigma P(\text{real}) - \Sigma Z(\text{real})}{P-Z}.$$

(b).

$$\sigma = \frac{0-4-2-2-(-2)}{3} = \frac{-4-2-\cancel{2}+\cancel{2}}{3} = \frac{-6}{3} = -2.$$

$$s = \frac{-4 \pm \sqrt{16-32}}{2}$$

$$= \frac{-4 \pm \sqrt{-16}}{2}$$

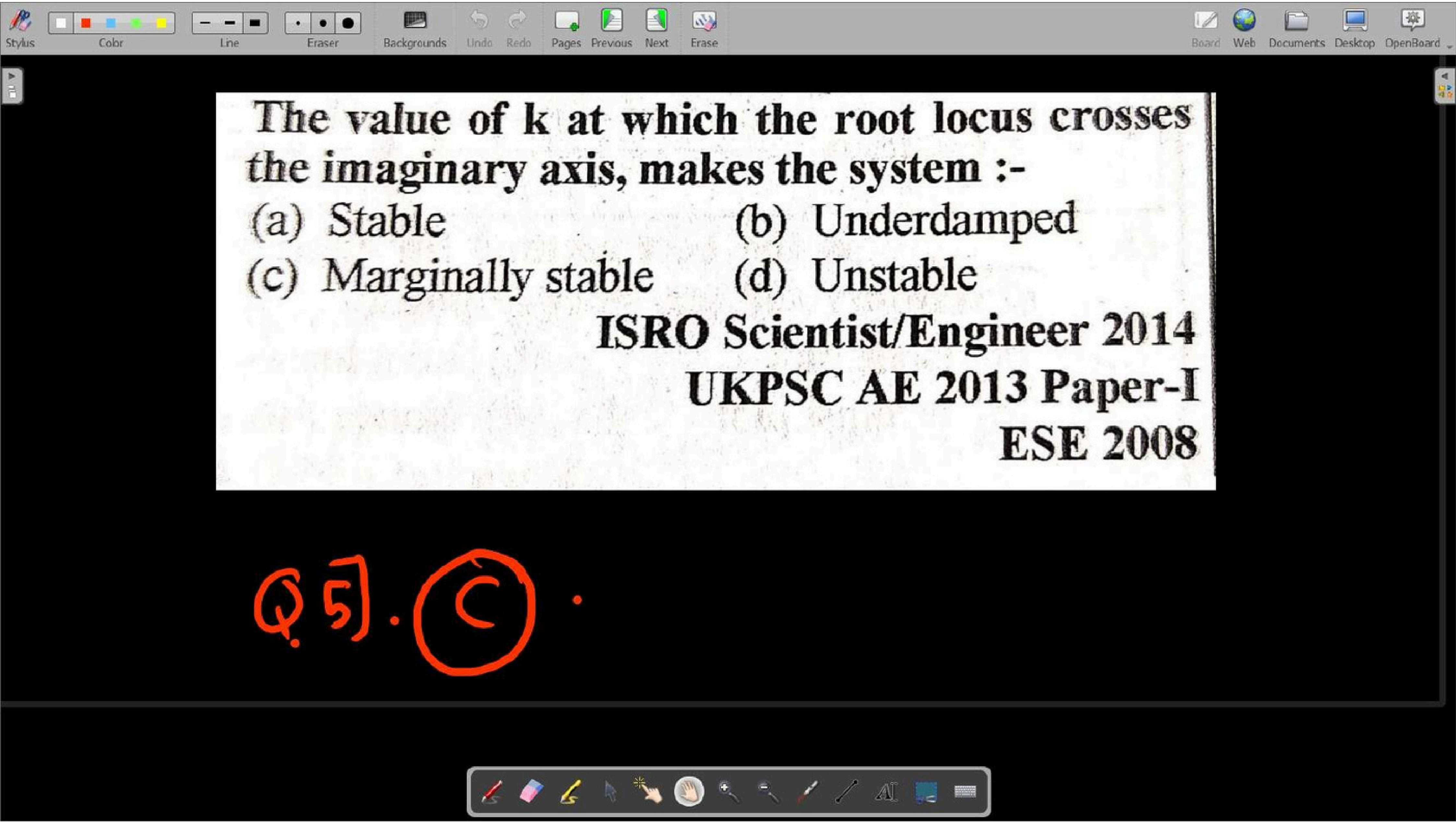
$$= \frac{-\overset{2}{4} \pm i\overset{2}{4}}{\cancel{2}}$$

$$= -2 \pm i4.$$

S=-4 S=-2 S=0

-2-i4 (-2,0).

Full Video Link



The value of k at which the root locus crosses the imaginary axis, makes the system :-

(a) Stable (b) Underdamped

(c) Marginally stable (d) Unstable

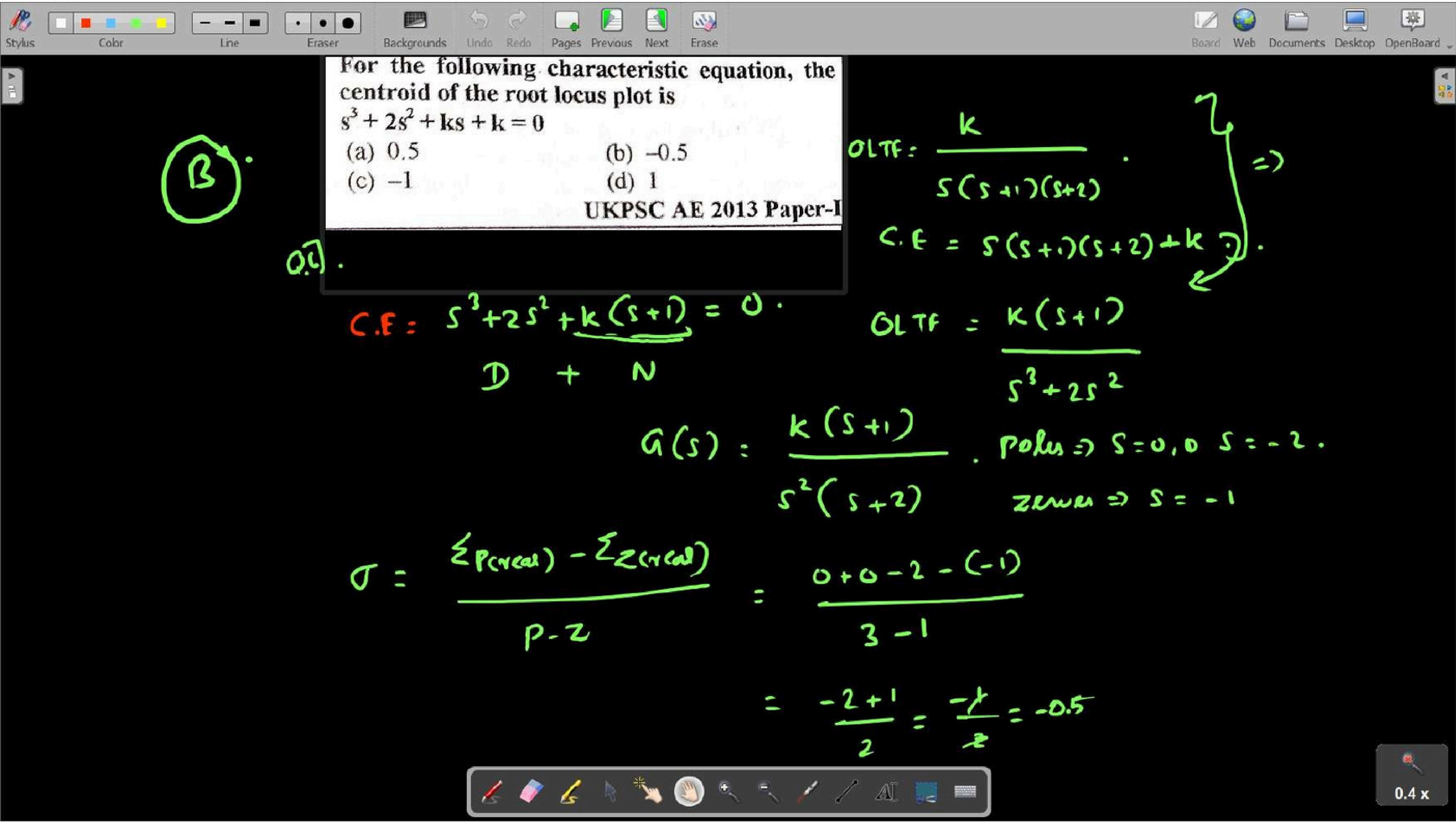
ISRO Scientist/Engineer 2014

UKPSC AE 2013 Paper-I

ESE 2008

Q57. ⓒ

Full Video Link



For the following characteristic equation, the centroid of the root locus plot is

$s^3 + 2s^2 + ks + k = 0$

(a) 0.5 (b) −0.5

(c) −1 (d) 1

UKPSC AE 2013 Paper-I

Ⓑ.

Q.7).

OLTF: $\dfrac{K}{s(s+1)(s+2)}$.

C.E = $s(s+1)(s+2)+k$ ⇒

C.E: $s^3+2s^2+\underline{k(s+1)} = 0.$

D + N

OLTF $= \dfrac{K(s+1)}{s^3+2s^2}$

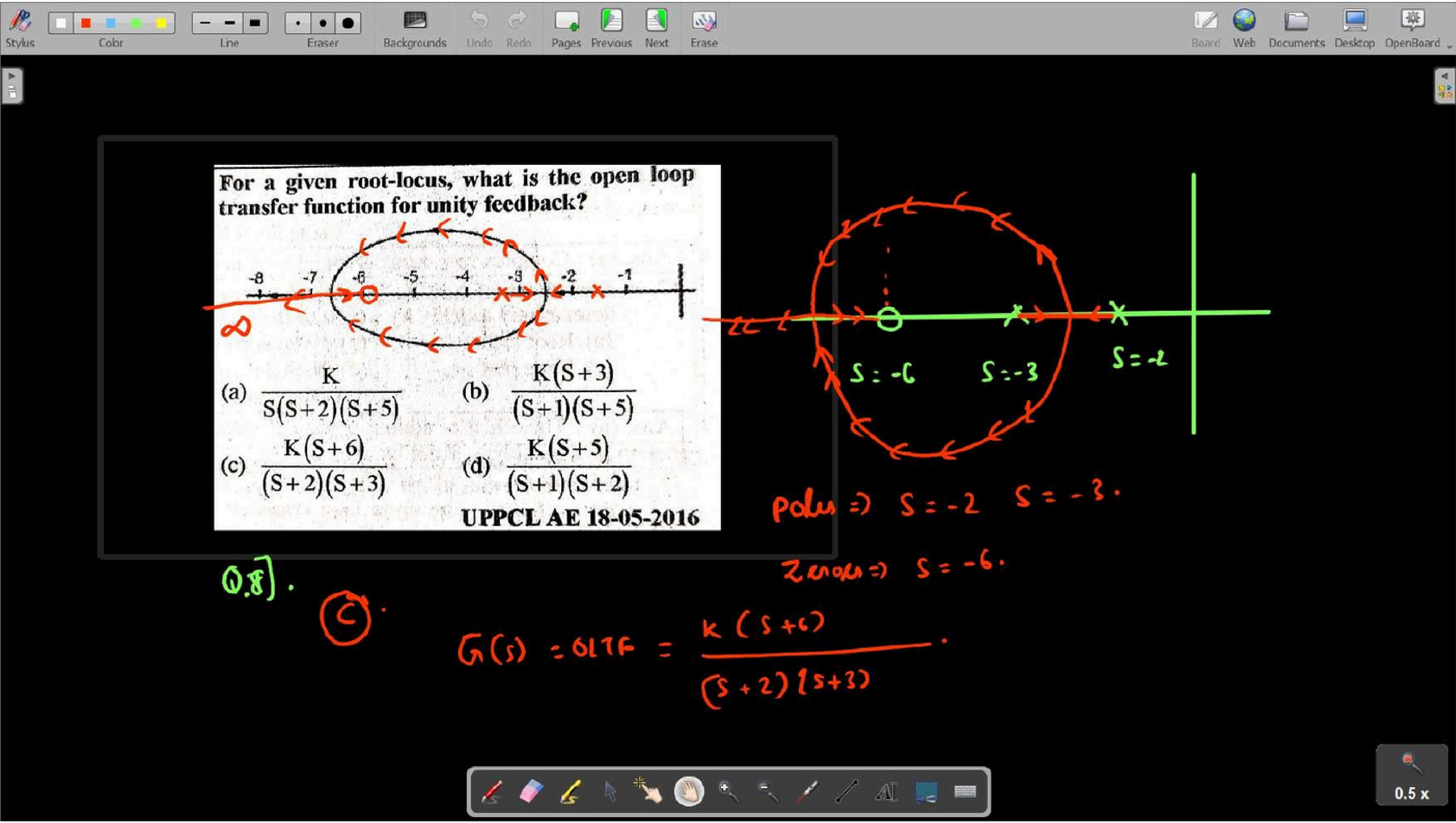
$G(s) : \dfrac{k(s+1)}{s^2(s+2)}$. poles ⇒ $s=0,0$ $s=-2$.

zeros ⇒ $s = -1$

$$\sigma = \frac{\Sigma p(\text{real}) - \Sigma z(\text{real})}{P-Z} = \frac{0+0-2-(-1)}{3-1}$$

$$= \frac{-2+1}{2} = \frac{-\cancel{1}}{\cancel{2}} = -0.5$$

Full Video Link



For a given root-locus, what is the open loop transfer function for unity feedback?

(a) $\frac{K}{S(S+2)(S+5)}$ (b) $\frac{K(S+3)}{(S+1)(S+5)}$

(c) $\frac{K(S+6)}{(S+2)(S+3)}$ (d) $\frac{K(S+5)}{(S+1)(S+2)}$

UPPCL AE 18-05-2016

Q.8].

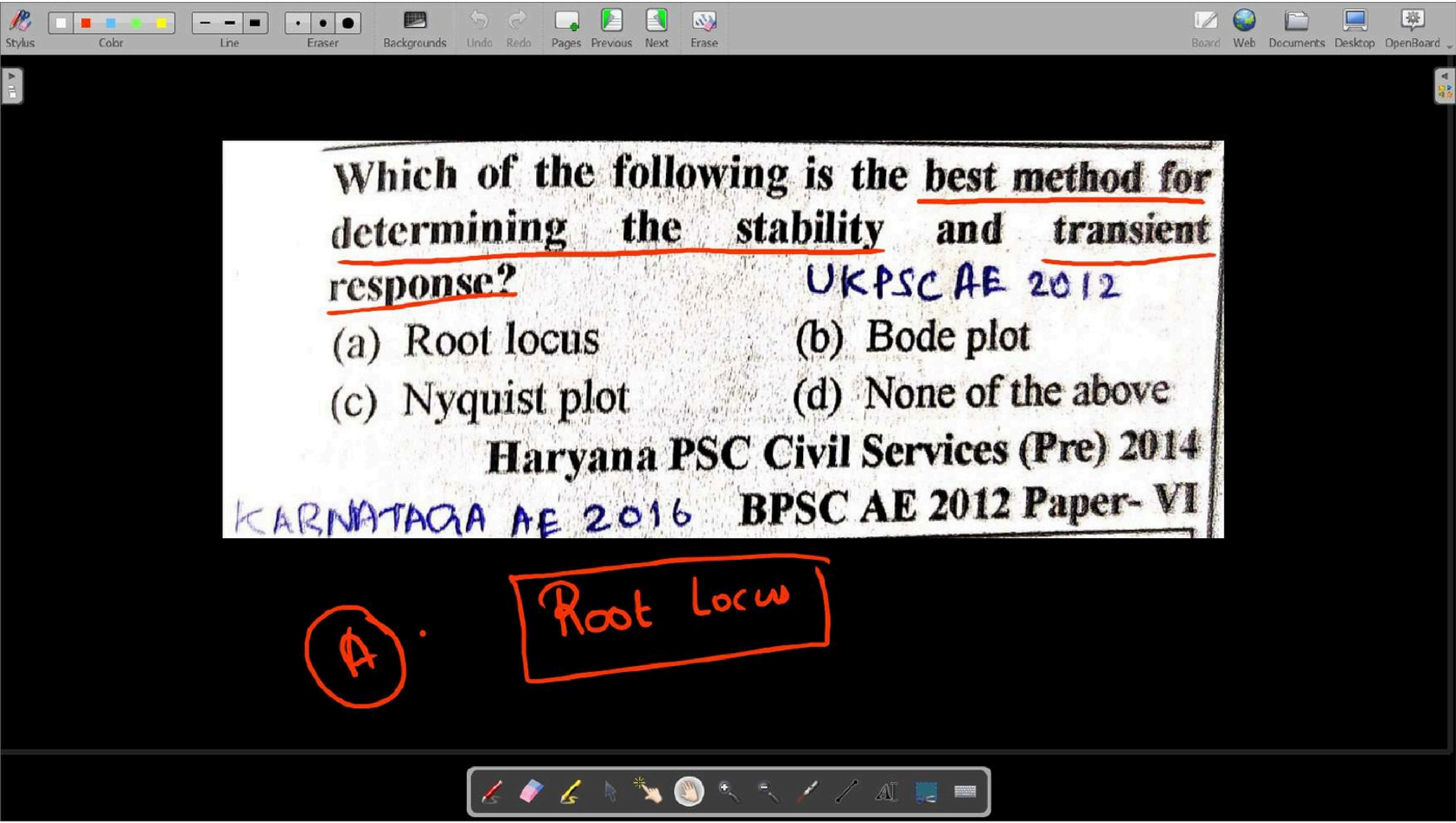
ⓒ.

poles => S = -2 S = -3.

Zeroes => S = -6.

$$G(s) = OLTF = \frac{k(s+6)}{(s+2)(s+3)}.$$

Full Video Link



Which of the following is the best method for determining the stability and transient response?

UKPSC AE 2012

(a) Root locus

(b) Bode plot

(c) Nyquist plot

(d) None of the above

Haryana PSC Civil Services (Pre) 2014

KARNATAKA AE 2016

BPSC AE 2012 Paper- VI

(A).

Root Locus

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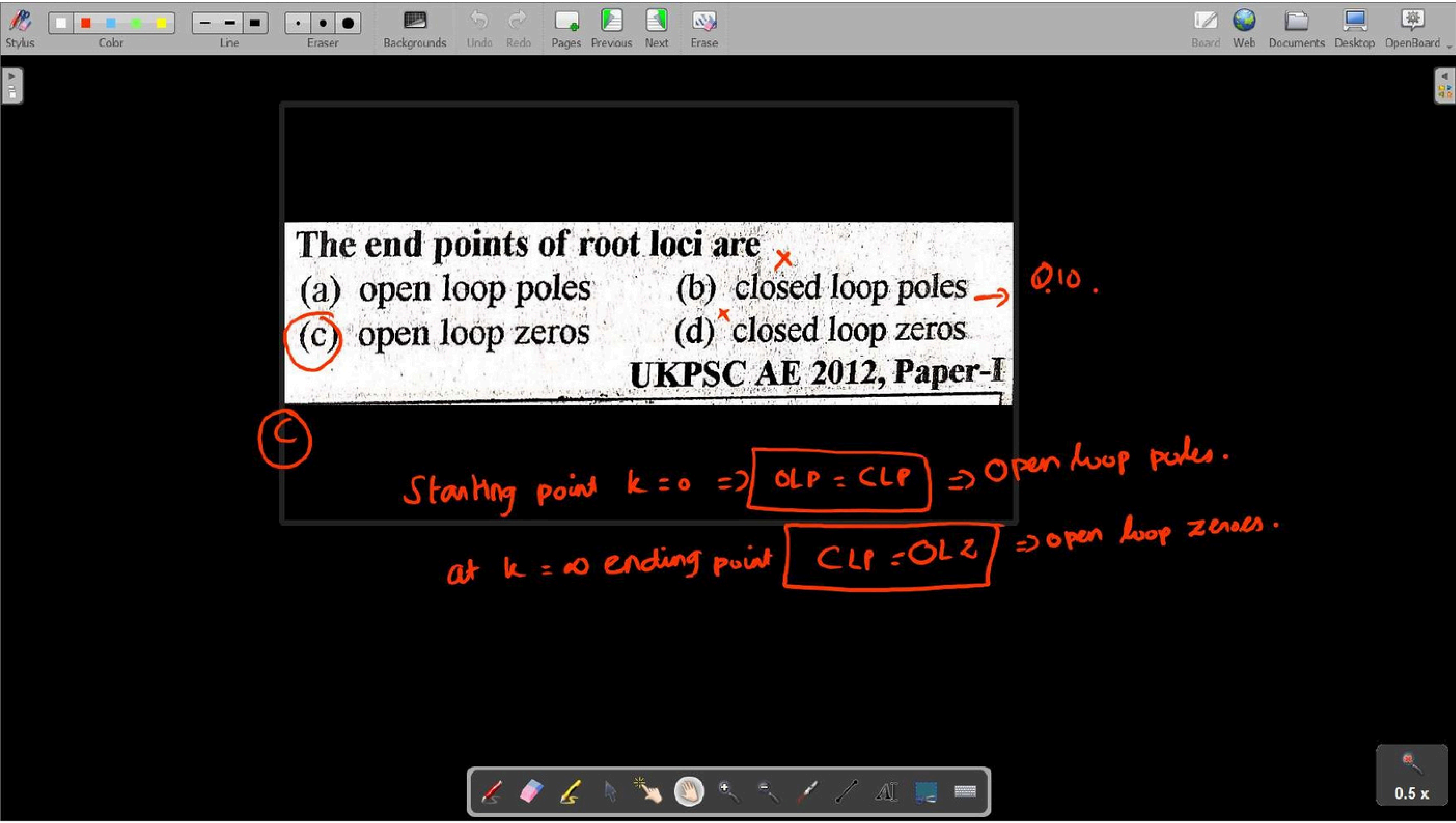


The end points of root loci are

(a) open loop poles

(b) closed loop poles → Q10.

[✓ (c)] open loop zeros

(d) closed loop zeros

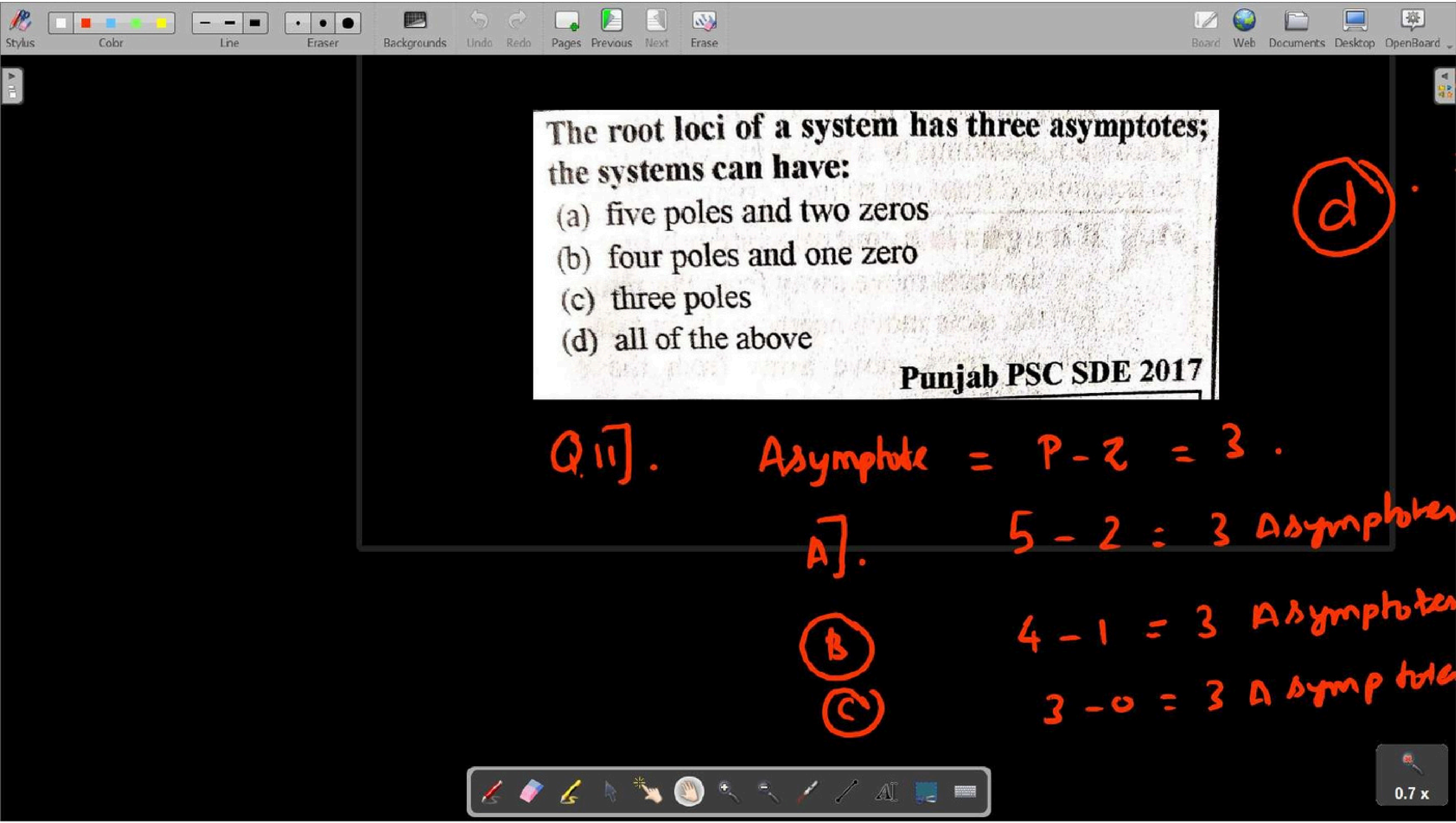
UKPSC AE 2012, Paper-I

ⓒ

Starting point $k = 0 \Rightarrow \boxed{OLP = CLP} \Rightarrow$ Open loop poles.

at $k = \infty$ ending point $\boxed{CLP = OLZ} \Rightarrow$ open loop zeroes.

Full Video Link



The root loci of a system has three asymptotes; the systems can have:

(a) five poles and two zeros

(b) four poles and one zero

(c) three poles

(d) all of the above

Punjab PSC SDE 2017

ⓓ.

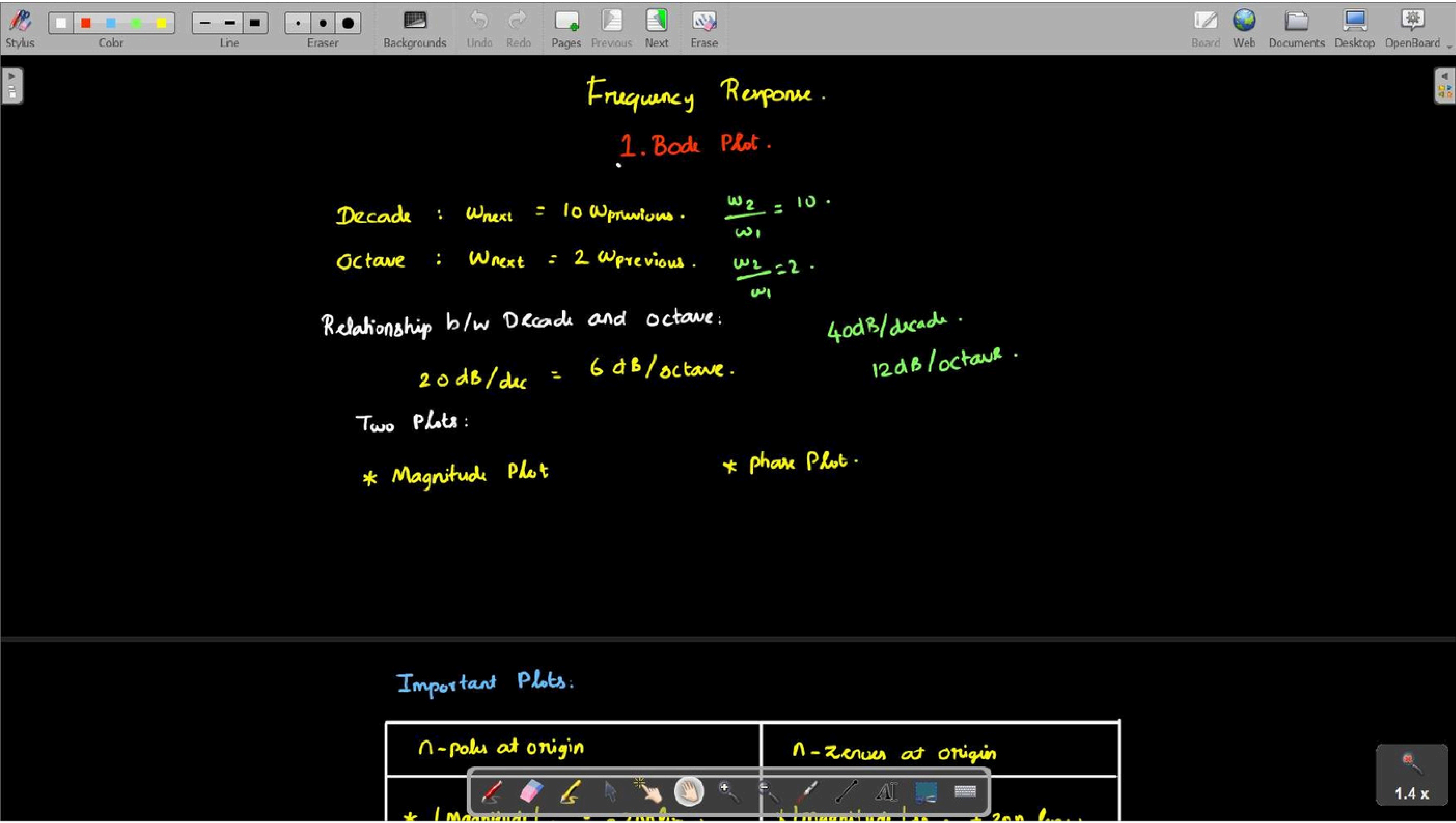
Q.11]. Asymptote = P - Z = 3.

A]. 5 - 2 : 3 Asymptote

Ⓑ 4 - 1 = 3 Asymptote

Ⓒ 3 - 0 = 3 Asymptote

Full Video Link



Frequency Response.

1. Bode Plot.

Decade : $\omega_{next} = 10\, \omega_{previous}$. $\frac{\omega_2}{\omega_1} = 10$.

Octave : $W_{next} = 2\, W_{previous}$. $\frac{\omega_2}{\omega_1} = 2$.

Relationship b/w Decade and octave:

20 dB/dec = 6 dB/octave.

40dB/decade.

12dB/octave.

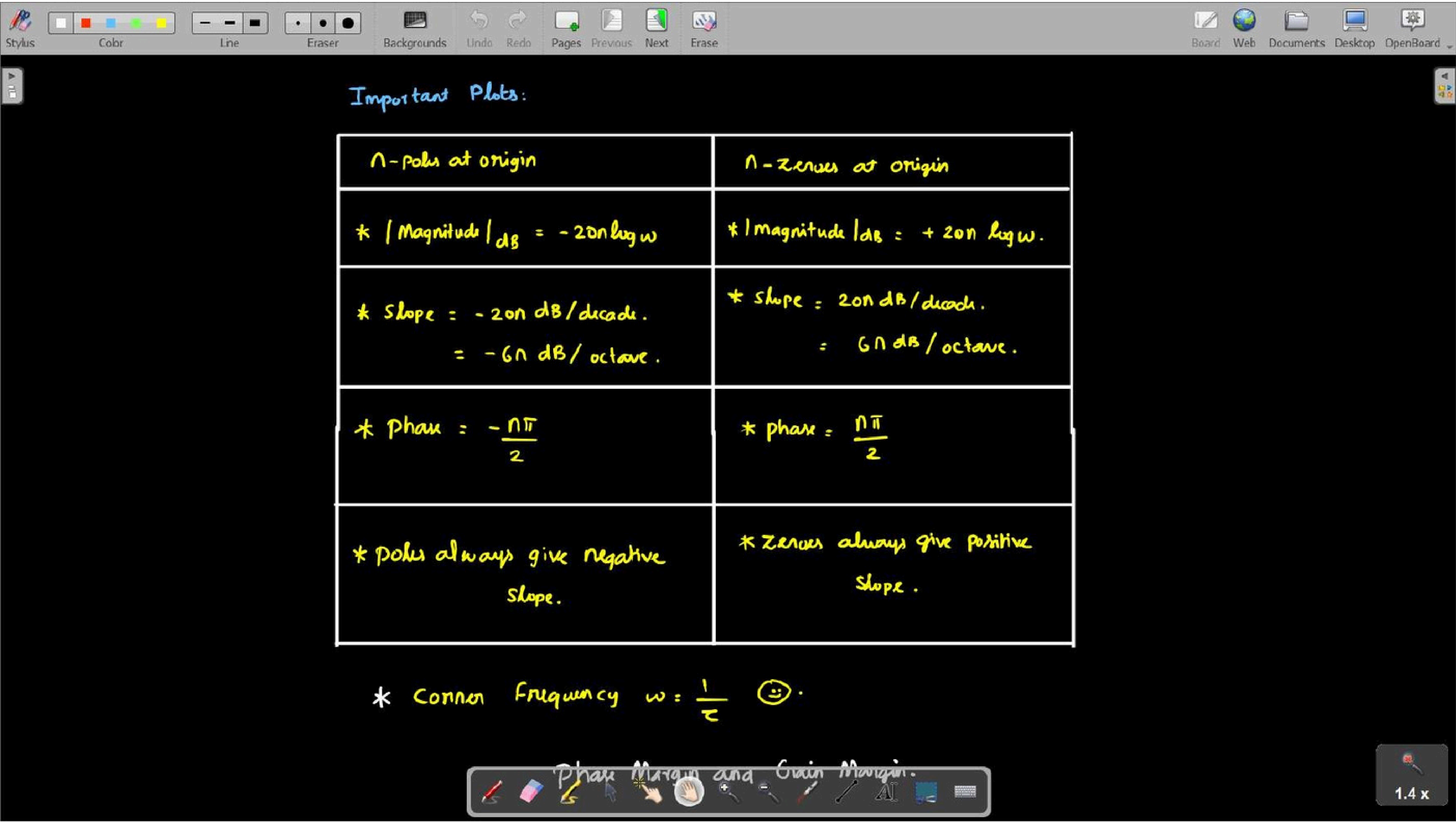
Two Plots:

- * Magnitude Plot
- * phase Plot.

Important Plots:

n-poles at origin	n-zeroes at origin

Full Video Link



Important Plots:

n-poles at origin	n-zeroes at origin
* $|Magnitude|_{dB} = -20n \log \omega$	* $|magnitude|_{dB} = +20n \log \omega$.
* Slope = -20n dB/decade. = -6n dB/octave.	* slope = 20n dB/decade. = 6n dB/octave.
* Phase = $-\frac{n\pi}{2}$	* phase = $\frac{n\pi}{2}$
* poles always give negative slope.	* Zeroes always give positive slope.

* Corner Frequency $\omega = \frac{1}{\tau}$ ☺.

Phase Margin and Gain Margin:

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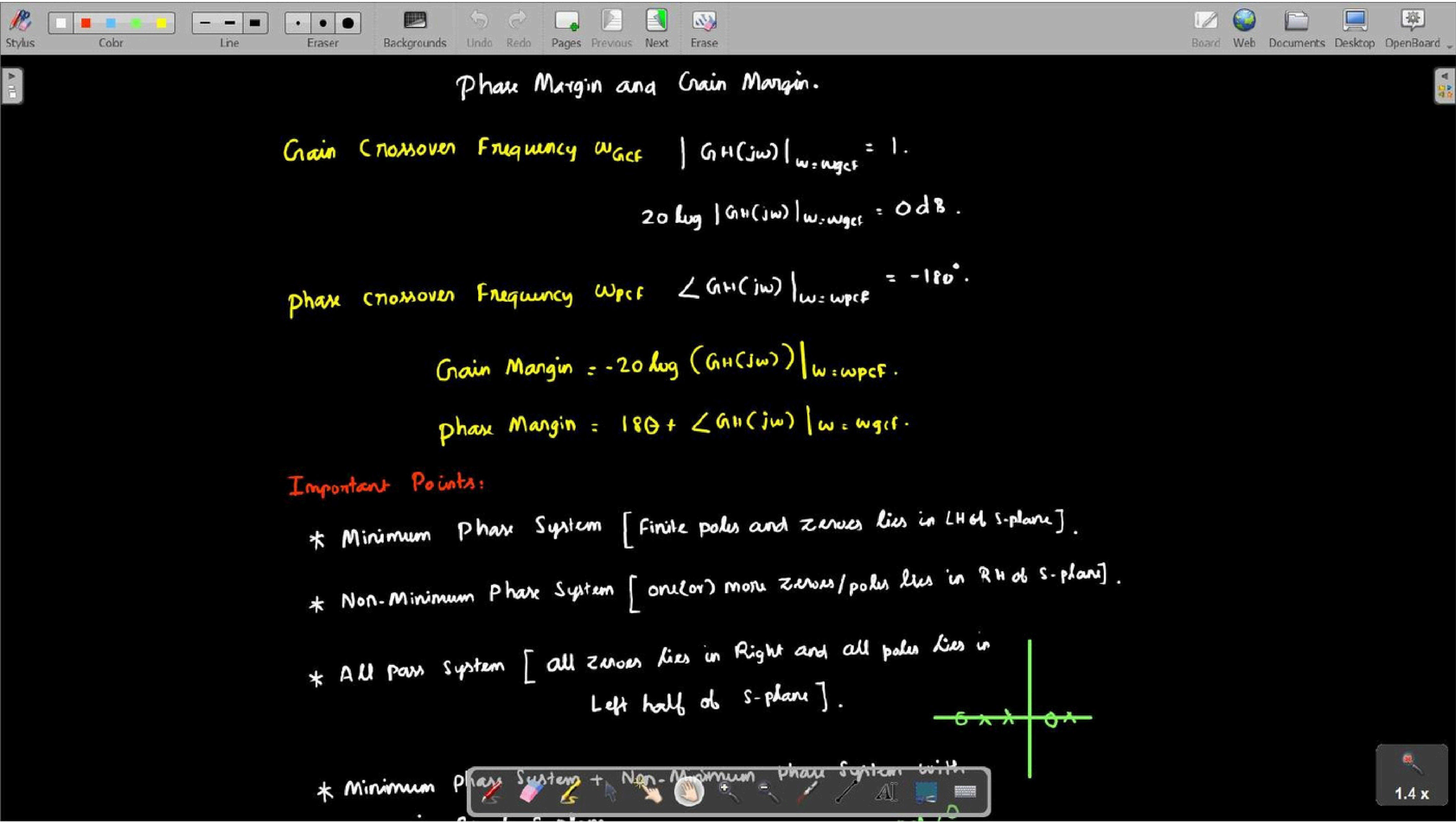

Phase Margin and Gain Margin.

Gain Crossover Frequency ω_{GCF} $\quad |GH(j\omega)|_{\omega=\omega_{gcf}} = 1.$

$$20 \log |GH(j\omega)|_{\omega=\omega_{gcf}} = 0\,dB.$$

phase crossover Frequency ω_{pcf} $\quad \angle GH(j\omega)|_{\omega=\omega_{pcf}} = -180^\circ.$

$$\text{Gain Margin} = -20 \log (GH(j\omega))|_{\omega=\omega_{pcF}}.$$

$$\text{phase Margin} = 180 + \angle GH(j\omega)|_{\omega=\omega_{gcf}}.$$

Important Points:

- * Minimum Phase System [Finite poles and zeroes lies in LH of s-plane].
- * Non-Minimum Phase System [one(or) more zeroes/poles lies in RH of S-plane].
- * All pass system [all zeroes lies in Right and all poles lies in Left half of s-plane].
- * Minimum Phase System + Non-Minimum phase System with

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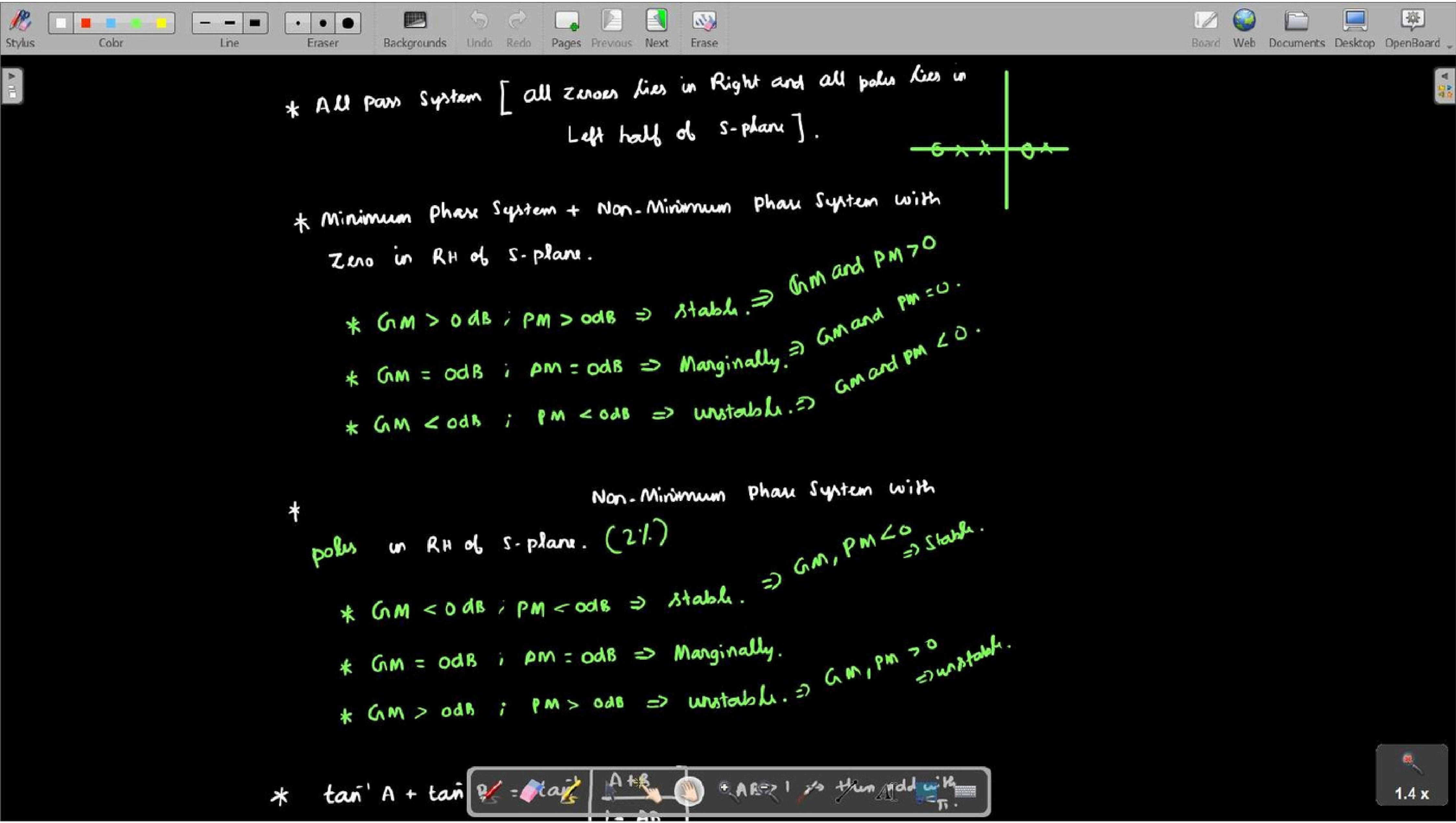

* All pass System [all zeroes lies in Right and all poles lies in Left half of S-plane].

* Minimum phase System + Non-Minimum phase System with Zero in RH of S-plane.

  * GM > 0 dB ; PM > 0dB ⇒ stable. ⇒ GM and PM > 0
  * GM = 0dB ; PM = 0dB ⇒ Marginally. ⇒ GM and PM = 0.
  * GM < 0dB ; PM < 0dB ⇒ unstable. ⇒ GM and PM < 0.

* Non-Minimum phase System with poles in RH of S-plane. (2%)

  * GM < 0 dB ; PM < 0dB ⇒ stable. ⇒ GM, PM < 0 ⇒ Stable.
  * GM = 0dB ; PM = 0dB ⇒ Marginally.
  * GM > 0dB ; PM > 0dB ⇒ unstable. ⇒ GM, PM > 0 ⇒ unstable.

* tan' A + tan

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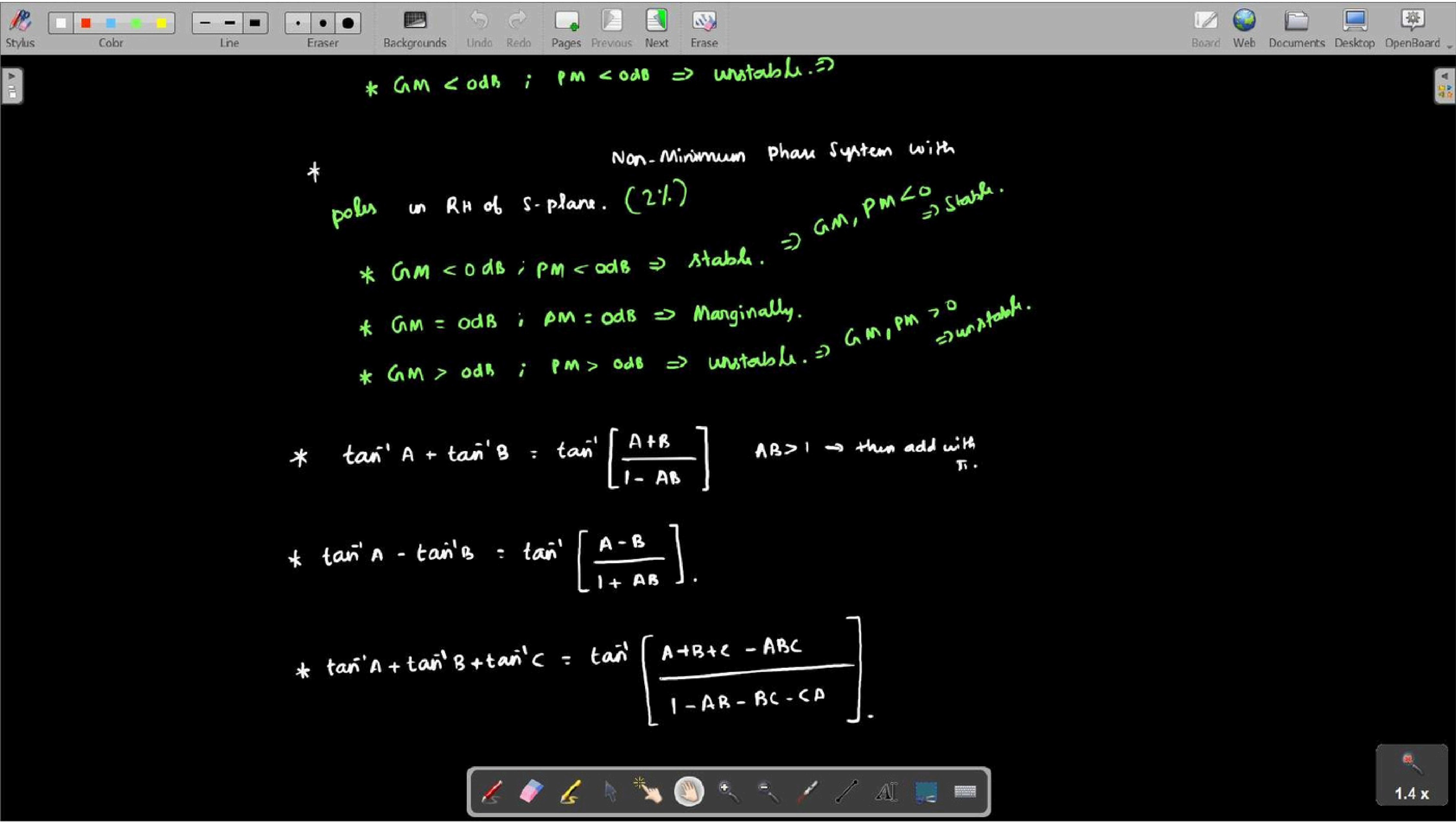


* $GM < 0dB$; $PM < 0dB$ ⇒ unstable. ⇒

* Non-Minimum Phase System with poles in RH of s-plane. (2%)

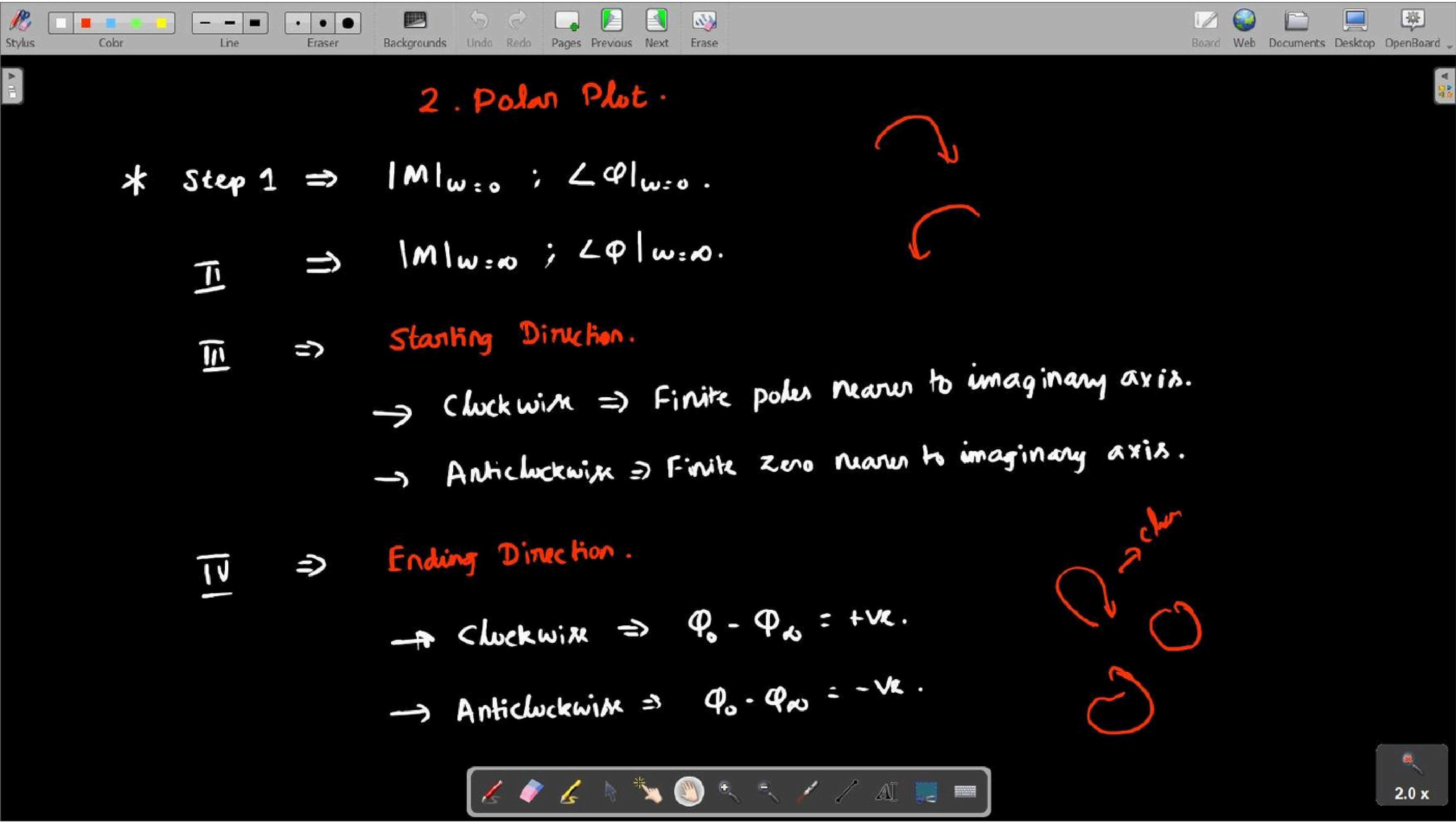
* $GM < 0\,dB$; $PM < 0dB$ ⇒ stable. ⇒ $GM, PM < 0$ ⇒ stable.
* $GM = 0dB$; $PM = 0dB$ ⇒ Marginally.
* $GM > 0dB$; $PM > 0dB$ ⇒ unstable. ⇒ $GM, PM > 0$ ⇒ unstable.

* $\tan^{-1} A + \tan^{-1} B = \tan^{-1}\left[\frac{A+B}{1-AB}\right]$ $AB > 1$ → then add with π.

* $\tan^{-1} A - \tan^{-1} B = \tan^{-1}\left[\frac{A-B}{1+AB}\right]$.

* $\tan^{-1} A + \tan^{-1} B + \tan^{-1} C = \tan^{-1}\left[\frac{A+B+C-ABC}{1-AB-BC-CA}\right]$.

Full Video Link



2. Polar Plot.

* Step 1 ⇒ $|M|_{w=0}$; $\angle\phi|_{w=0}$.

II ⇒ $|M|_{w=\infty}$; $\angle\phi|_{w=\infty}$.

III ⇒ Starting Direction.

→ Clockwise ⇒ Finite poles nearer to imaginary axis.

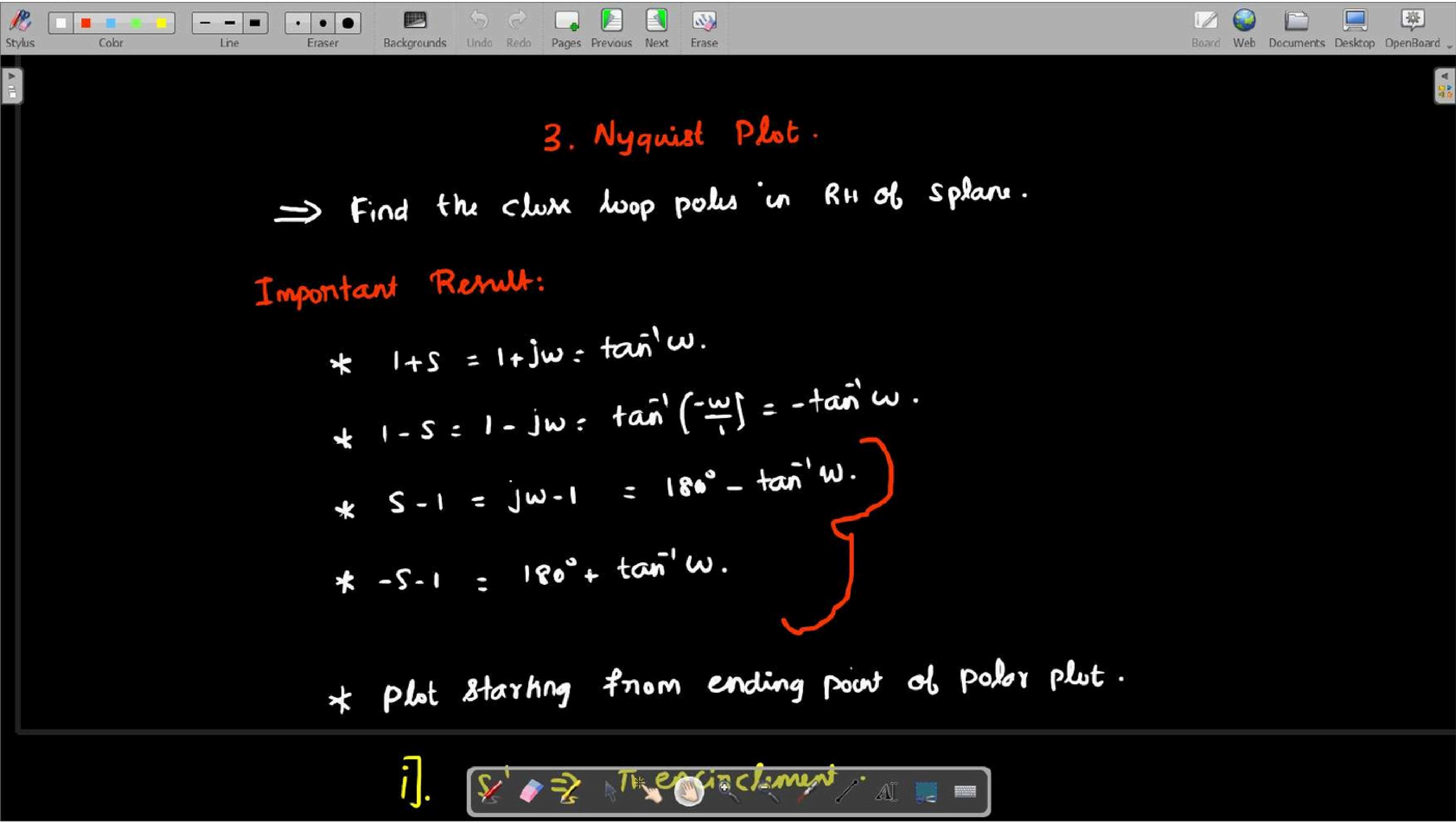
→ Anticlockwise ⇒ Finite zero nearer to imaginary axis.

IV ⇒ Ending Direction.

→ Clockwise ⇒ $\phi_0 - \phi_\infty = +ve$.

→ Anticlockwise ⇒ $\phi_0 - \phi_\infty = -ve$.

Full Video Link



3. Nyquist Plot.

⇒ Find the close loop poles in RH of splane.

Important Result:

* $1+s = 1+j\omega = \tan^{-1}\omega$.

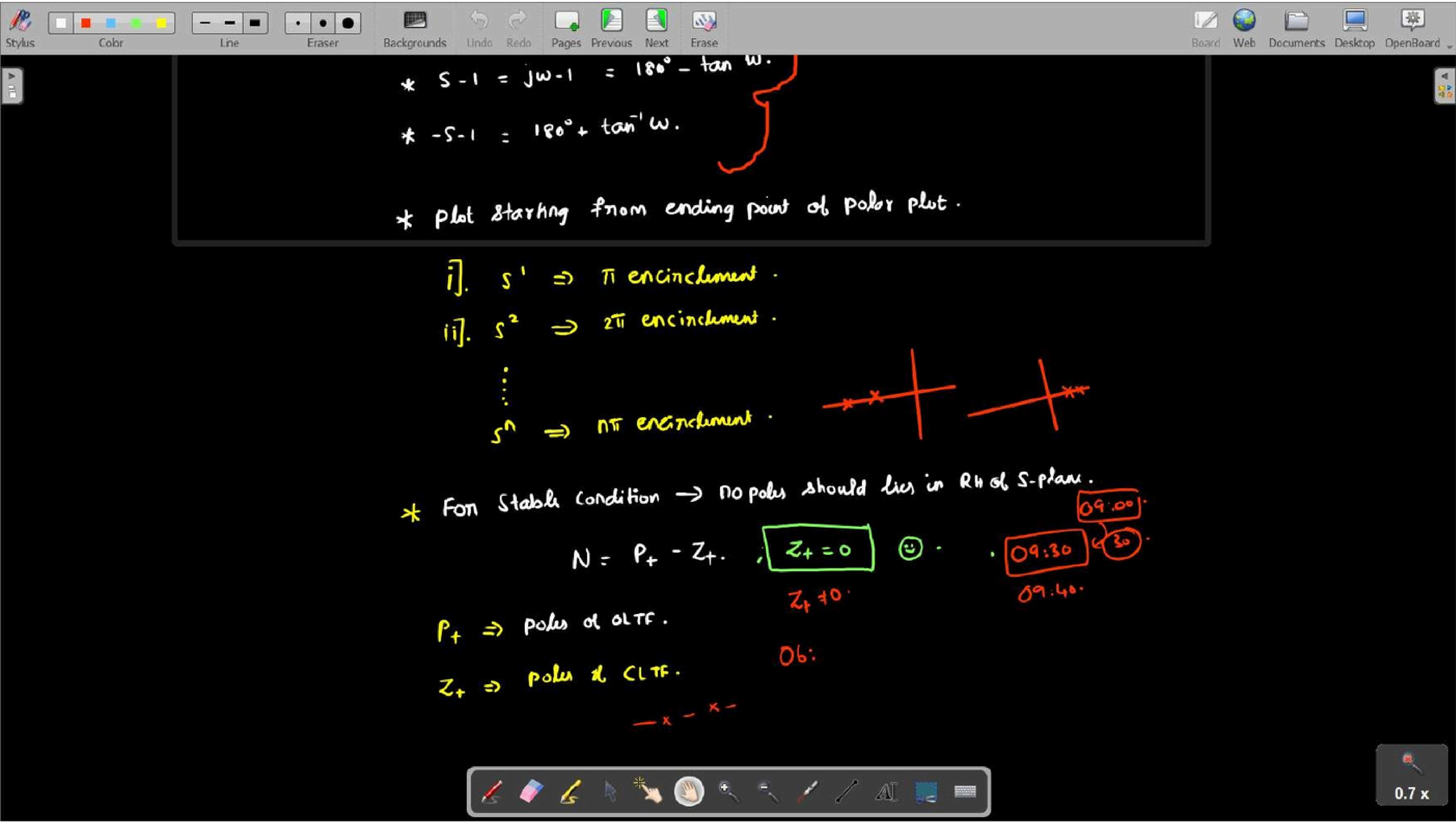
* $1-s = 1-j\omega = \tan^{-1}\left(\frac{-\omega}{1}\right) = -\tan^{-1}\omega$.

$$\left.\begin{array}{l} * \; s-1 = j\omega-1 = 180^\circ - \tan^{-1}\omega. \\ * \; -s-1 = 180^\circ + \tan^{-1}\omega. \end{array}\right\}$$

* plot starting from ending point of polar plot.

i]. The encirclement.

Full Video Link



* $S-1 = j\omega - 1 = 180° - \tan \omega.$

* $-S-1 = 180° + \tan^{-1}\omega.$

* plot starting from ending point of polor plot.

i]. $s^1 \Rightarrow \pi$ encinclement.

ii]. $s^2 \Rightarrow 2\pi$ encinclement.

⋮

$s^n \Rightarrow n\pi$ encinclement.

* Fon Stable condition → no poles should lies in RH of S-plane.

$N = P_+ - Z_+.$; $\boxed{Z_+ = 0}$ ☺.

$Z_+ \neq 0.$

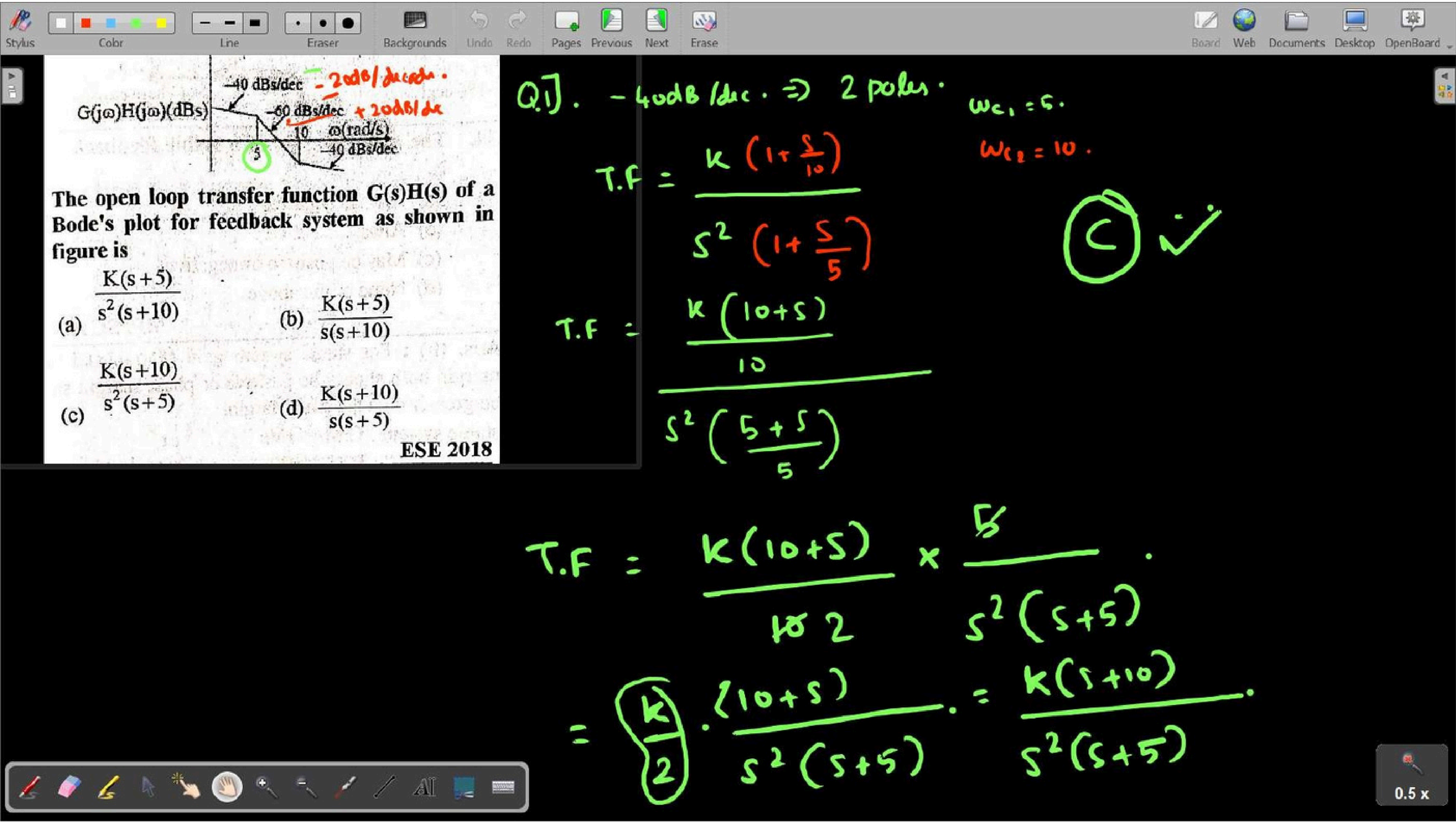
$\boxed{09:00}$. $\boxed{09:30}$ ③⓪. 09:40.

$P_+ \Rightarrow$ poles of OLTF.

06:

$Z_+ \Rightarrow$ poles of CLTF.

—x—x—



The open loop transfer function G(s)H(s) of a Bode's plot for feedback system as shown in figure is

(a) $\frac{K(s+5)}{s^2(s+10)}$ (b) $\frac{K(s+5)}{s(s+10)}$

(c) $\frac{K(s+10)}{s^2(s+5)}$ (d) $\frac{K(s+10)}{s(s+5)}$

ESE 2018

Q.1]. −40dB/dec. ⇒ 2 poles.

$\omega_{c_1} = 5.$

$\omega_{c_2} = 10.$

$$T.F = \frac{K\left(1+\frac{s}{10}\right)}{s^2\left(1+\frac{s}{5}\right)}$$

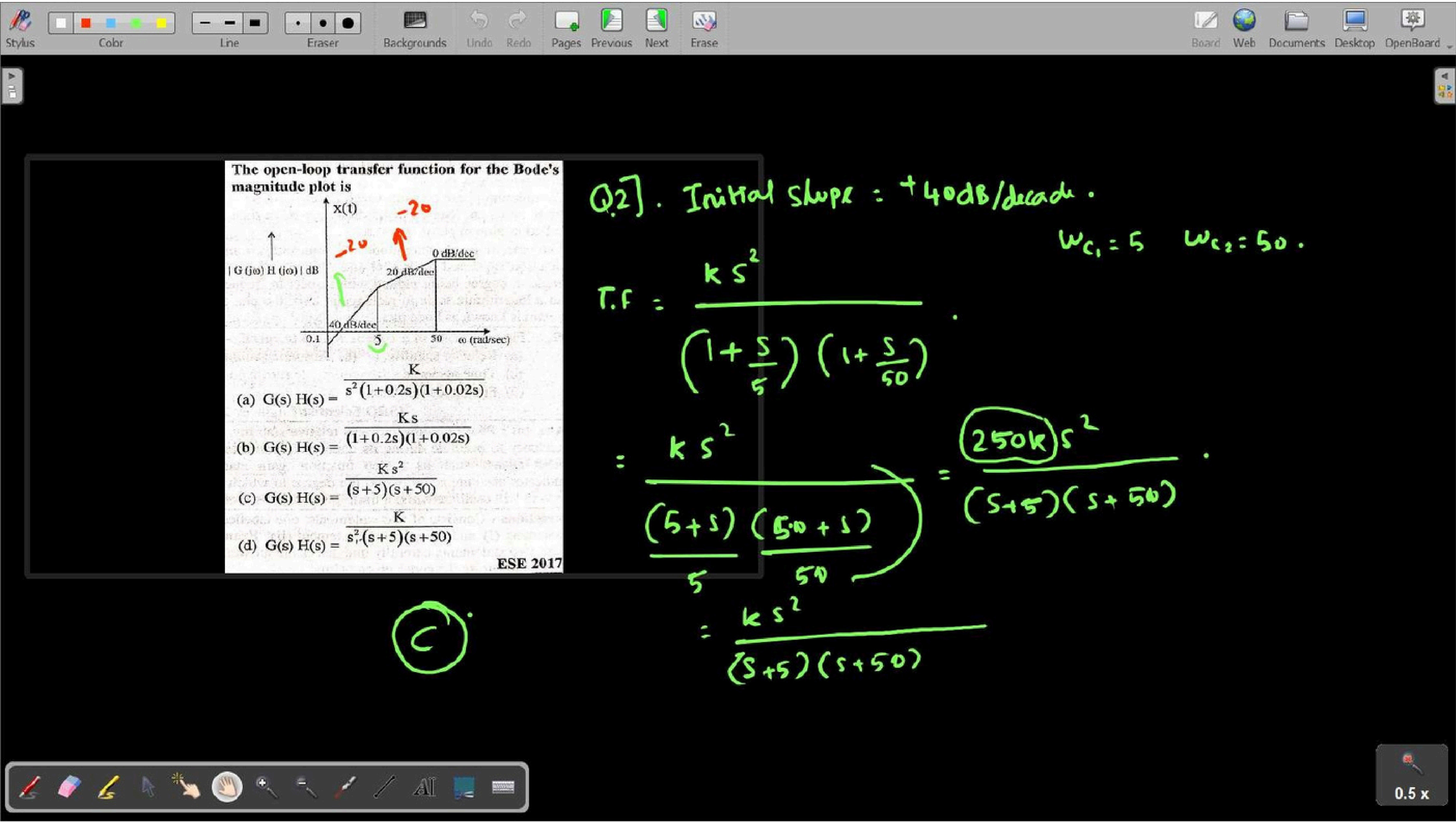
(C) ✓

$$T.F = \frac{\frac{K(10+s)}{10}}{s^2\left(\frac{5+s}{5}\right)}$$

$$T.F = \frac{K(10+s)}{\cancel{10}\,2} \times \frac{\cancel{5}}{s^2(s+5)}.$$

$$= \boxed{\frac{K}{2}} \cdot \frac{(10+s)}{s^2(s+5)}. = \frac{K(s+10)}{s^2(s+5)}.$$

Full Video Link



The open-loop transfer function for the Bode's magnitude plot is

(a) $G(s)\,H(s) = \dfrac{K}{s^2(1+0.2s)(1+0.02s)}$

(b) $G(s)\,H(s) = \dfrac{Ks}{(1+0.2s)(1+0.02s)}$

(c) $G(s)\,H(s) = \dfrac{Ks^2}{(s+5)(s+50)}$

(d) $G(s)\,H(s) = \dfrac{K}{s^2(s+5)(s+50)}$

ESE 2017

$\textcircled{c}$.

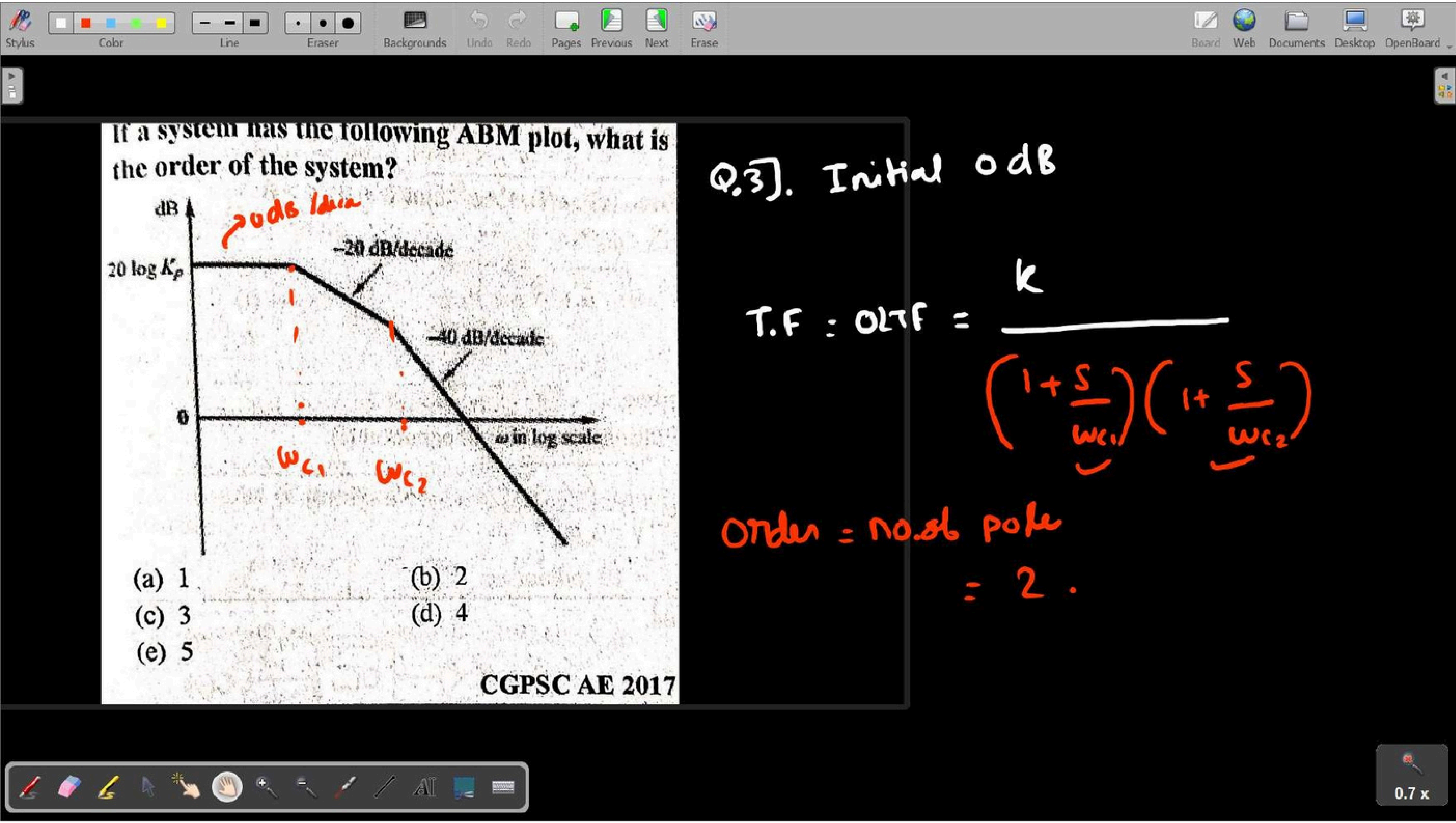
Q2]. Initial slope : +40dB/decade.

$\omega_{c_1} = 5 \quad \omega_{c_2} = 50.$

$$T.F = \frac{Ks^2}{\left(1+\frac{s}{5}\right)\left(1+\frac{s}{50}\right)}.$$

$$= \frac{Ks^2}{\frac{(5+s)}{5}\,\frac{(50+s)}{50}} = \frac{\boxed{250K}\,s^2}{(s+5)(s+50)}.$$

$$= \frac{Ks^2}{(s+5)(s+50)}$$



If a system has the following ABM plot, what is the order of the system?

(a) 1
(b) 2
(c) 3
(d) 4
(e) 5

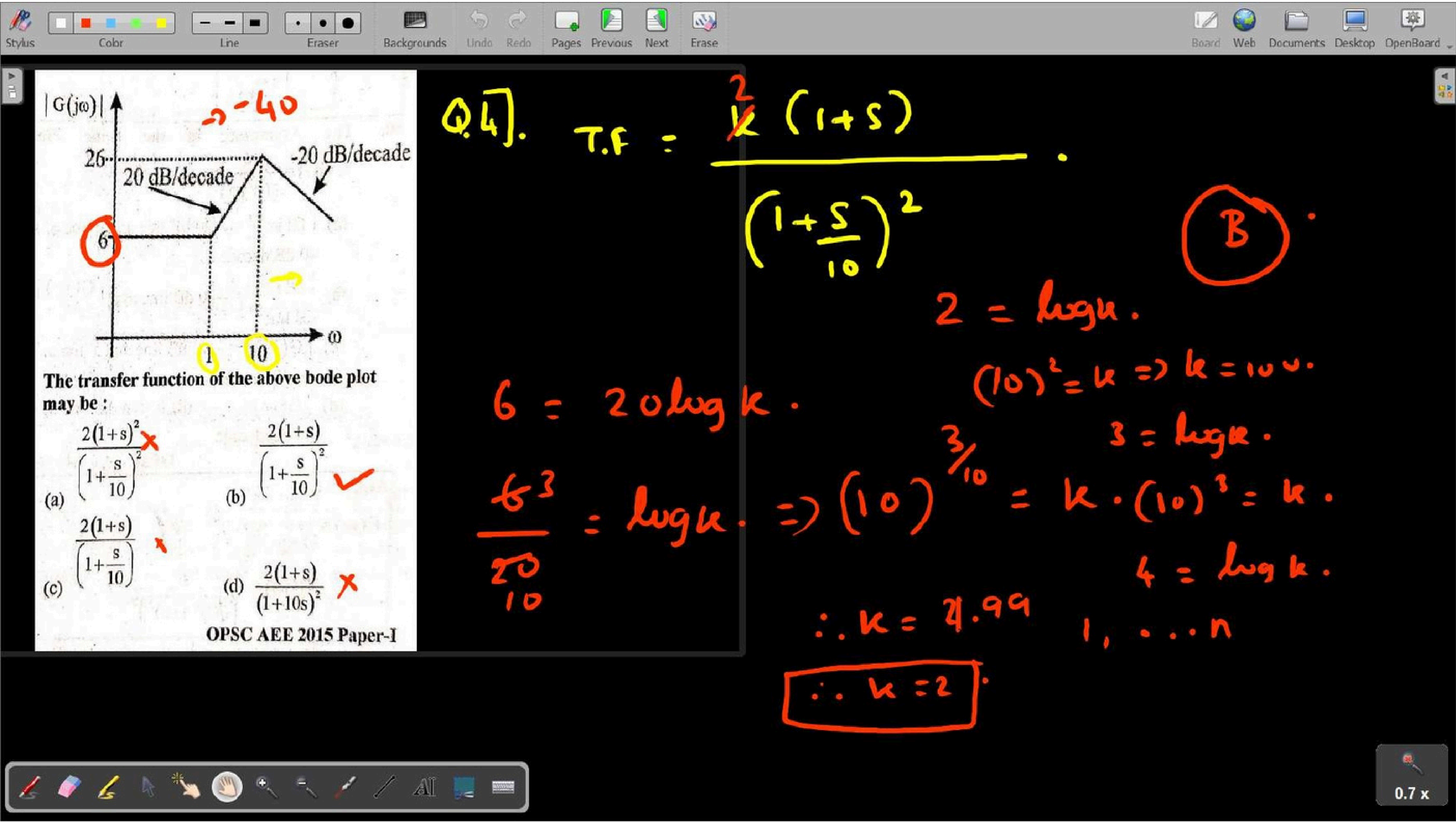
CGPSC AE 2017

Q.3]. Initial 0 dB

$$T.F : OLTF = \frac{k}{\left(1+\frac{s}{\underline{\omega_{c1}}}\right)\left(1+\frac{s}{\underline{\omega_{c2}}}\right)}$$

Order = no. of pole
= 2.

Full Video Link



The transfer function of the above bode plot may be :

(a) $\frac{2(1+s)^2}{\left(1+\frac{s}{10}\right)^2}$ ✗

(b) $\frac{2(1+s)}{\left(1+\frac{s}{10}\right)^2}$ ✓

(c) $\frac{2(1+s)}{\left(1+\frac{s}{10}\right)}$

(d) $\frac{2(1+s)}{(1+10s)^2}$ ✗

OPSC AEE 2015 Paper-I

Q.4].

$$T.F = \frac{\overset{2}{\cancel{k}}\,(1+s)}{\left(1+\frac{s}{10}\right)^2}.$$

$\boxed{B}$.

$2 = \log k.$

$(10)^2 = k \Rightarrow k = 100.$

$3 = \log k.$

$4 = \log k.$

$1, \ldots n$

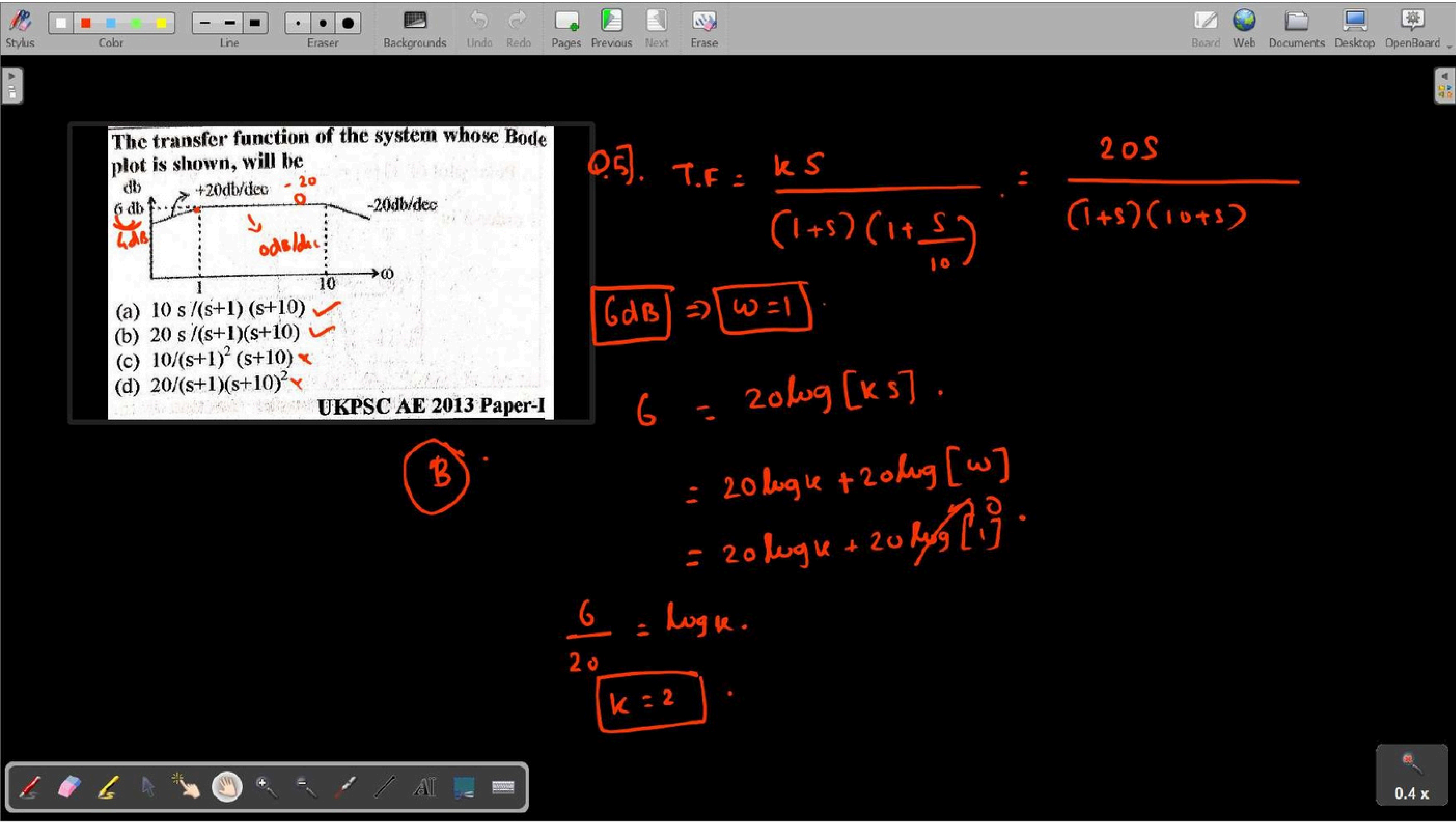
$6 = 20 \log k.$

$\frac{\cancel{6}^{3}}{\cancel{20}_{10}} = \log k. \Rightarrow (10)^{3/10} = k. \; (10)^3 = k.$

$\therefore k = 1.99$

$\boxed{\therefore k = 2}$.

Full Video Link



The transfer function of the system whose Bode plot is shown, will be

(a) $10\ s/(s+1)\ (s+10)$ ✓

(b) $20\ s/(s+1)(s+10)$ ✓

(c) $10/(s+1)^2\ (s+10)$ ✗

(d) $20/(s+1)(s+10)^2$ ✗

UKPSC AE 2013 Paper-I

Q5]. $T.F = \dfrac{ks}{(1+s)(1+\frac{s}{10})} = \dfrac{20s}{(1+s)(10+s)}$

$\boxed{6dB} \Rightarrow \boxed{\omega = 1}$.

$6 = 20\log[ks]$.

$= 20\log k + 20\log[\omega]$

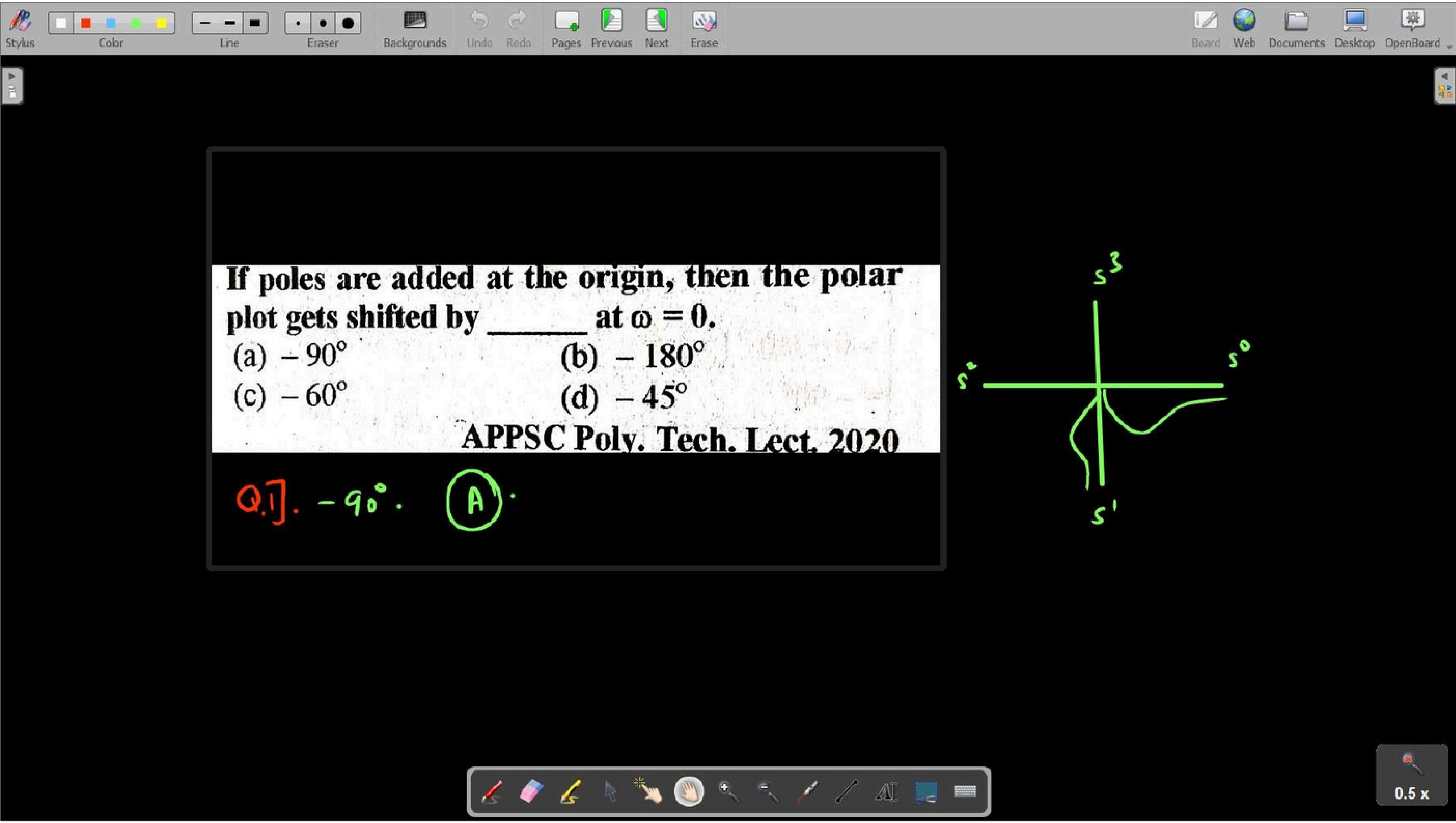
$= 20\log k + 20\,\cancel{\log}\overset{0}{[1]}$.

$\dfrac{6}{20} = \log k$.

$\boxed{k = 2}$.

(B).

Full Video Link ▶



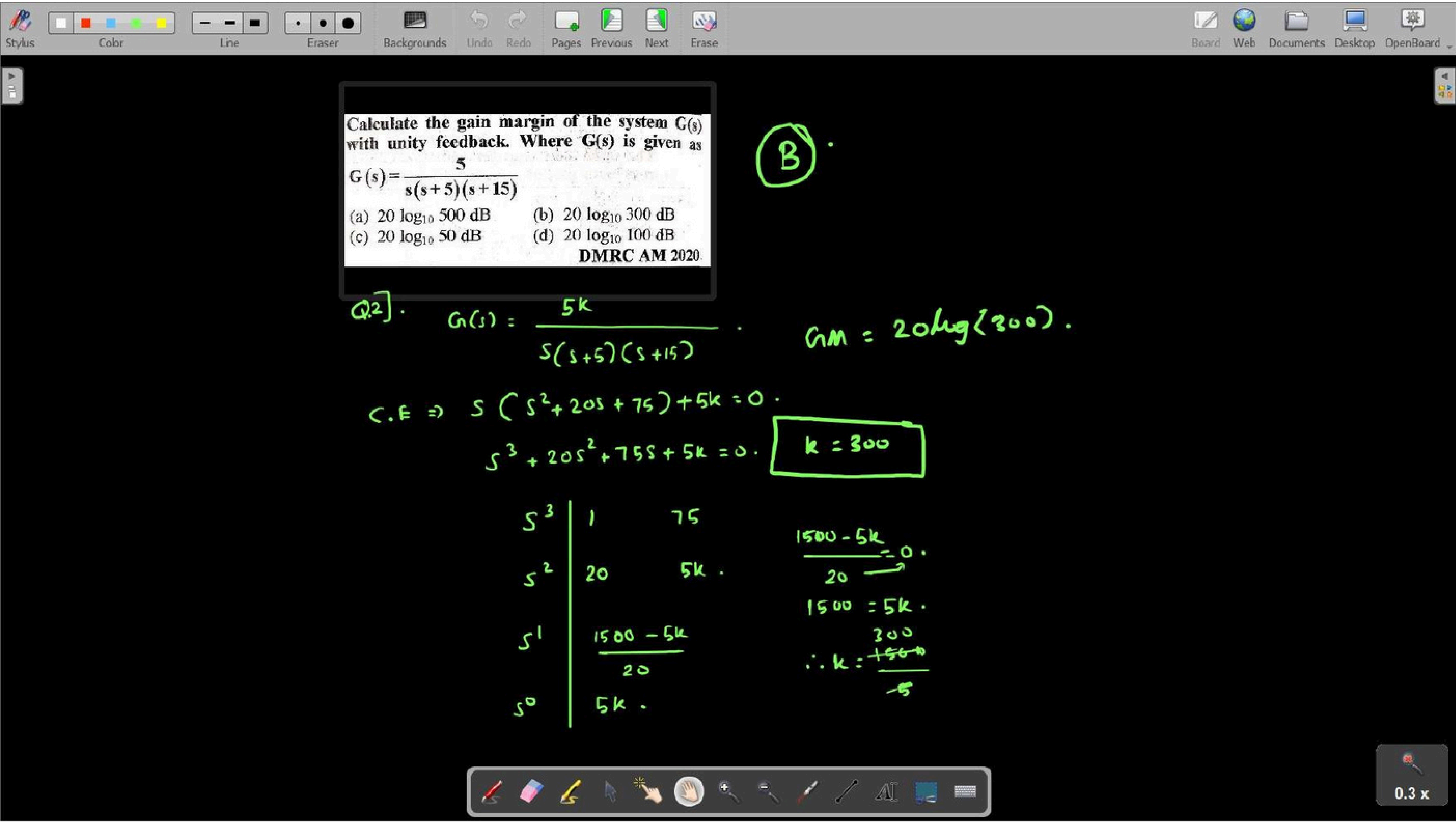
If poles are added at the origin, then the polar plot gets shifted by ______ at ω = 0.

(a) – 90°
(b) – 180°
(c) – 60°
(d) – 45°

APPSC Poly. Tech. Lect. 2020

Q.1]. –90°. (A).

Full Video Link



Calculate the gain margin of the system G(s) with unity feedback. Where G(s) is given as

$$G(s)=\frac{5}{s(s+5)(s+15)}$$

(a) $20\log_{10} 500$ dB (b) $20\log_{10} 300$ dB

(c) $20\log_{10} 50$ dB (d) $20\log_{10} 100$ dB

DMRC AM 2020

Ⓑ.

Q2].

$$G(s) = \frac{5k}{s(s+5)(s+15)}.$$

$$GM = 20\log(300).$$

$$C.E \Rightarrow s(s^2+20s+75)+5k=0.$$

$$s^3+20s^2+75s+5k=0.$$

$$\boxed{k=300}$$

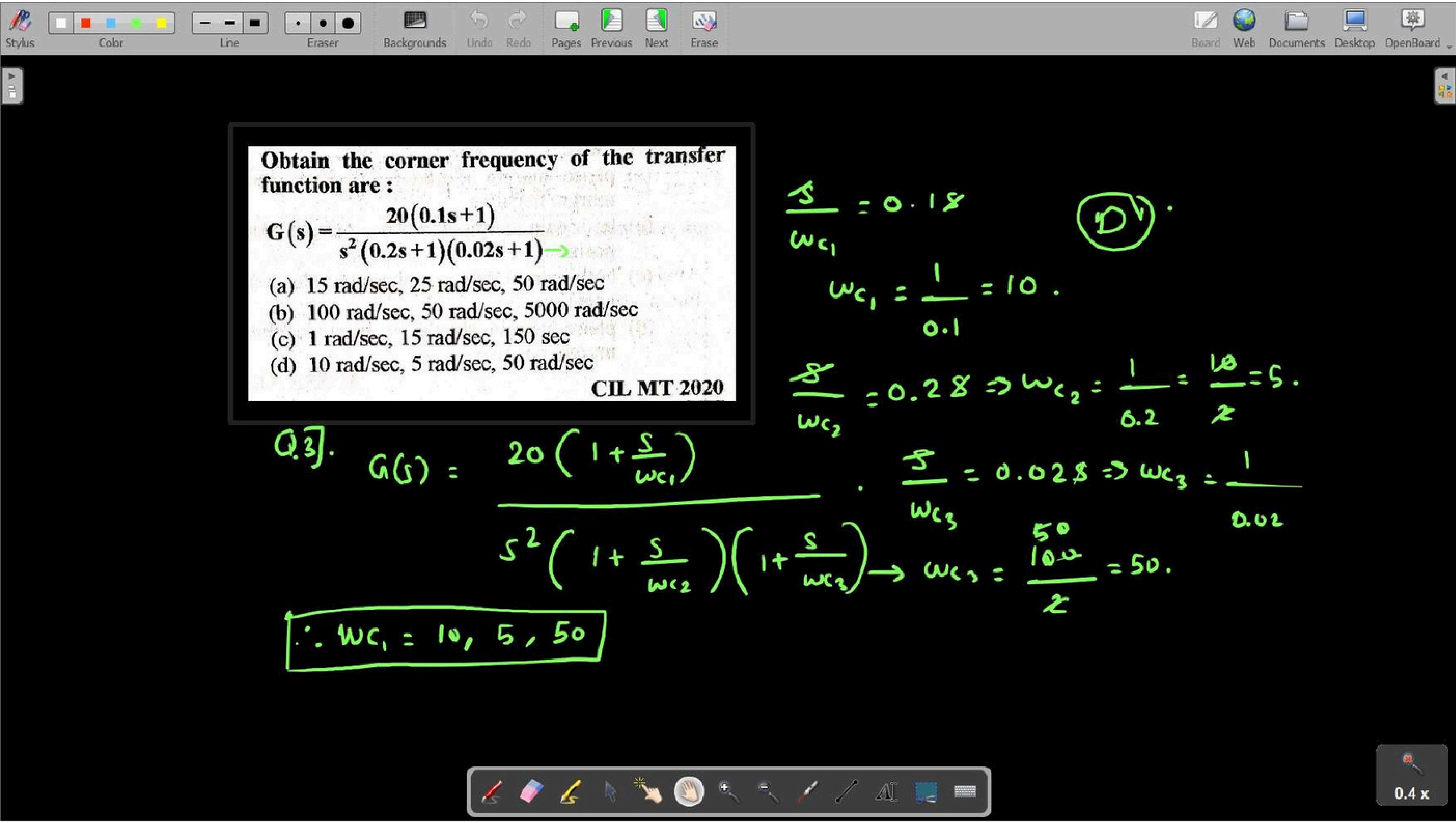
$$\begin{array}{c|cc} s^3 & 1 & 75 \\ s^2 & 20 & 5k. \\ s^1 & \frac{1500-5k}{20} & \\ s^0 & 5k. & \end{array}$$

$$\frac{1500-5k}{20}=0.$$

$$1500 = 5k.$$

$$\therefore k = \frac{\overset{300}{\cancel{1500}}}{\cancel{5}}$$

Full Video Link



Obtain the corner frequency of the transfer function are :

$$G(s)=\frac{20(0.1s+1)}{s^2(0.2s+1)(0.02s+1)} \rightarrow$$

(a) 15 rad/sec, 25 rad/sec, 50 rad/sec
(b) 100 rad/sec, 50 rad/sec, 5000 rad/sec
(c) 1 rad/sec, 15 rad/sec, 150 sec
(d) 10 rad/sec, 5 rad/sec, 50 rad/sec

CIL MT 2020

Q.3].

$$G(s) = \frac{20\left(1+\frac{s}{\omega_{c_1}}\right)}{s^2\left(1+\frac{s}{\omega_{c_2}}\right)\left(1+\frac{s}{\omega_{c_3}}\right)} \rightarrow$$

$$\frac{s}{\omega_{c_1}} = 0.1s \qquad \boxed{D}\ ✓.$$

$$\omega_{c_1} = \frac{1}{0.1} = 10.$$

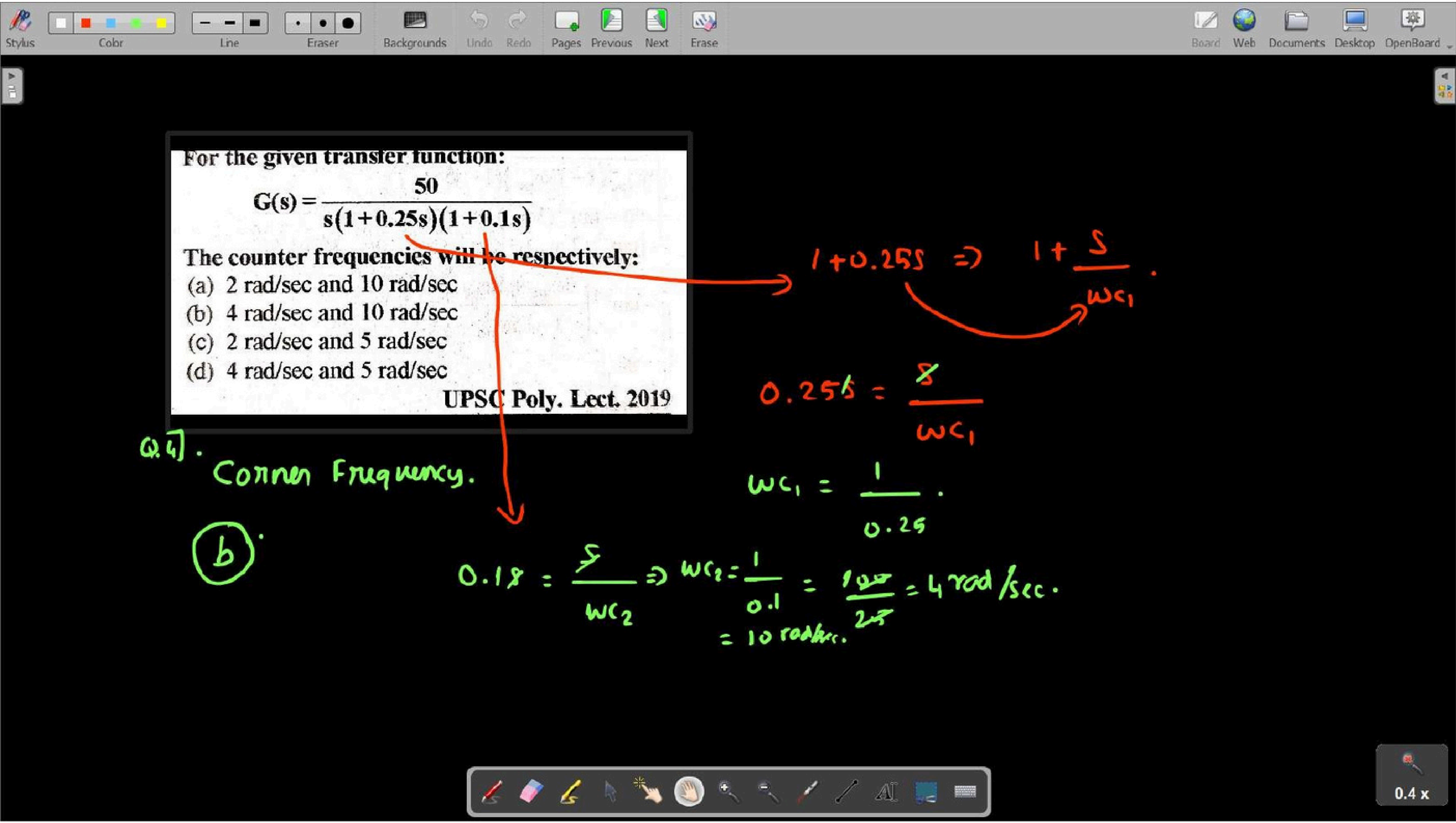
$$\frac{s}{\omega_{c_2}} = 0.2s \Rightarrow \omega_{c_2} = \frac{1}{0.2} = \frac{\cancel{10}}{\cancel{2}} = 5.$$

$$\frac{s}{\omega_{c_3}} = 0.02s \Rightarrow \omega_{c_3} = \frac{1}{0.02}$$

$$\omega_{c_3} = \frac{\overset{50}{\cancel{100}}}{\cancel{2}} = 50.$$

$$\boxed{\therefore \omega_{c_1} = 10,\ 5,\ 50}$$

Full Video Link



For the given transfer function:

$$G(s) = \frac{50}{s(1+0.25s)(1+0.1s)}$$

The counter frequencies will be respectively:

(a) 2 rad/sec and 10 rad/sec
(b) 4 rad/sec and 10 rad/sec
(c) 2 rad/sec and 5 rad/sec
(d) 4 rad/sec and 5 rad/sec

UPSC Poly. Lect. 2019

Q.4].

Corner Frequency.

ⓑ.

$1+0.25S \Rightarrow 1+\frac{S}{\omega c_1}$.

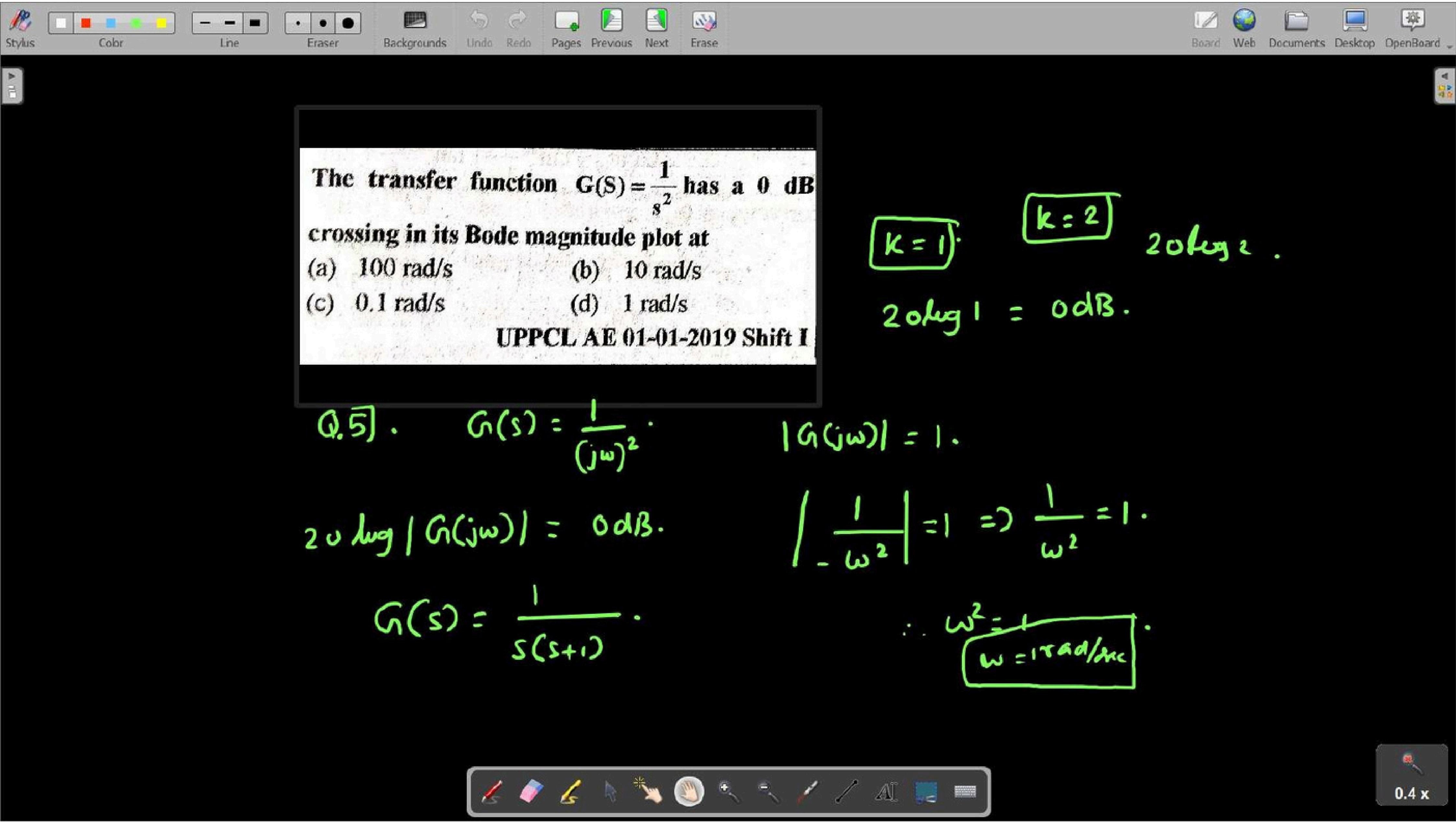
$0.25\cancel{S} = \frac{\cancel{S}}{\omega c_1}$

$\omega c_1 = \frac{1}{0.25}$.

$0.1\cancel{S} = \frac{\cancel{S}}{\omega c_2} \Rightarrow \omega c_2 = \frac{1}{0.1} = 10$ rad/sec.

$= \frac{100}{25} = 4$ rad/sec.

Full Video Link



The transfer function $G(S) = \frac{1}{s^2}$ has a 0 dB crossing in its Bode magnitude plot at

(a) 100 rad/s (b) 10 rad/s

(c) 0.1 rad/s (d) 1 rad/s

UPPCL AE 01-01-2019 Shift I

$\boxed{K=1}$. $\boxed{k=2}$ 20log2 .

20log1 = 0dB.

Q.5] . $G(s) = \frac{1}{(j\omega)^2}$. $|G(j\omega)| = 1.$

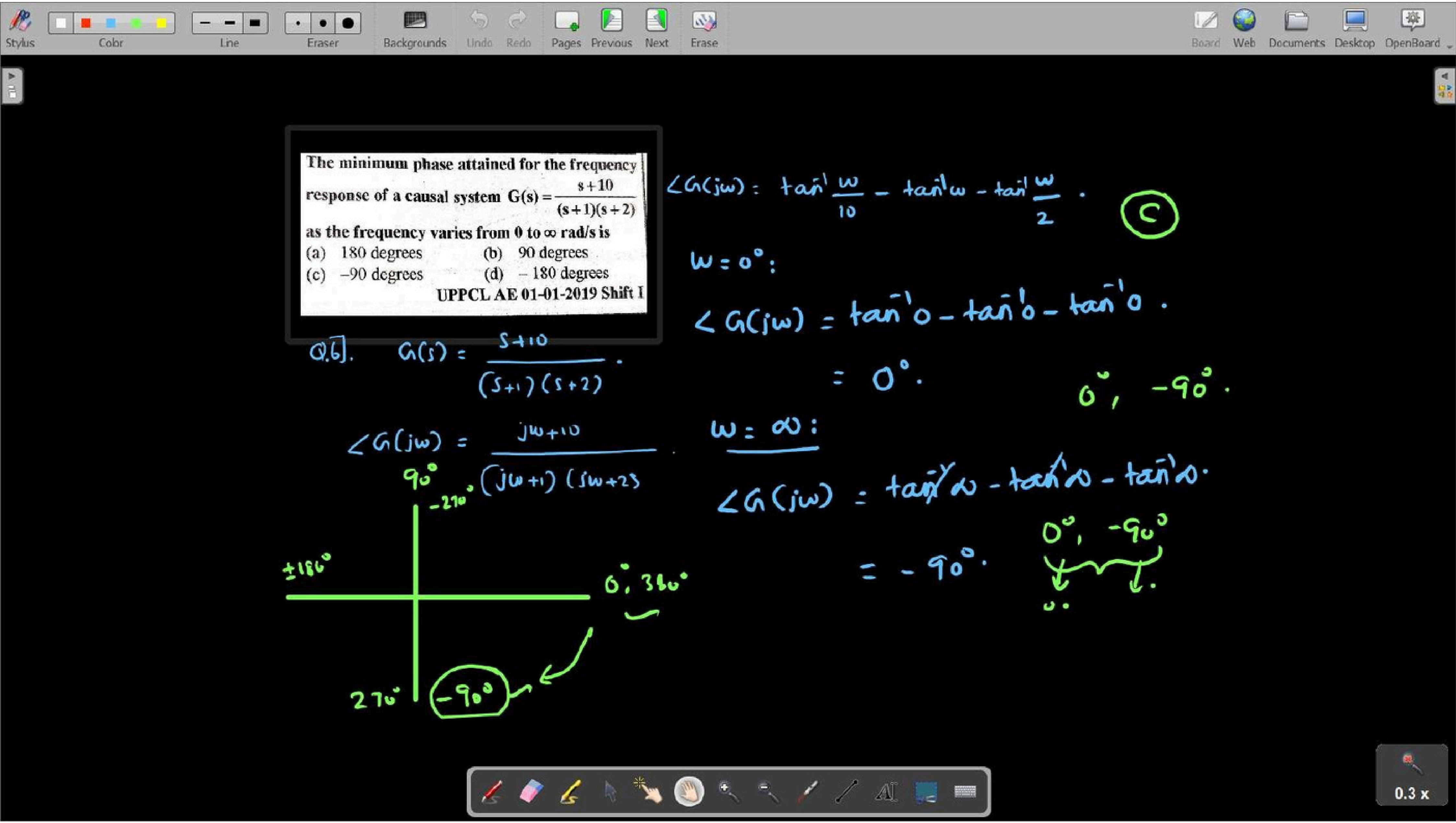
$20\log|G(j\omega)| = 0dB.$

$\left|\frac{1}{-\omega^2}\right| = 1 \Rightarrow \frac{1}{\omega^2} = 1.$

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

$\therefore \omega^2 = 1.$ $\boxed{\omega = 1 rad/sec}$

Full Video Link



The minimum phase attained for the frequency response of a causal system $G(s)=\frac{s+10}{(s+1)(s+2)}$ as the frequency varies from 0 to ∞ rad/s is

(a) 180 degrees (b) 90 degrees

(c) −90 degrees (d) − 180 degrees

UPPCL AE 01-01-2019 Shift I

Q.6]. $G(s) = \frac{s+10}{(s+1)(s+2)}$.

$\angle G(j\omega) = \frac{j\omega+10}{(j\omega+1)(j\omega+2)}$

90°

$\angle G(j\omega) = \tan^{-1}\frac{\omega}{10} - \tan^{-1}\omega - \tan^{-1}\frac{\omega}{2}$. ⓒ

$\omega = 0^\circ$:

$\angle G(j\omega) = \tan^{-1}0 - \tan^{-1}0 - \tan^{-1}0$.

$= 0^\circ$.

$0^\circ, -90^\circ$.

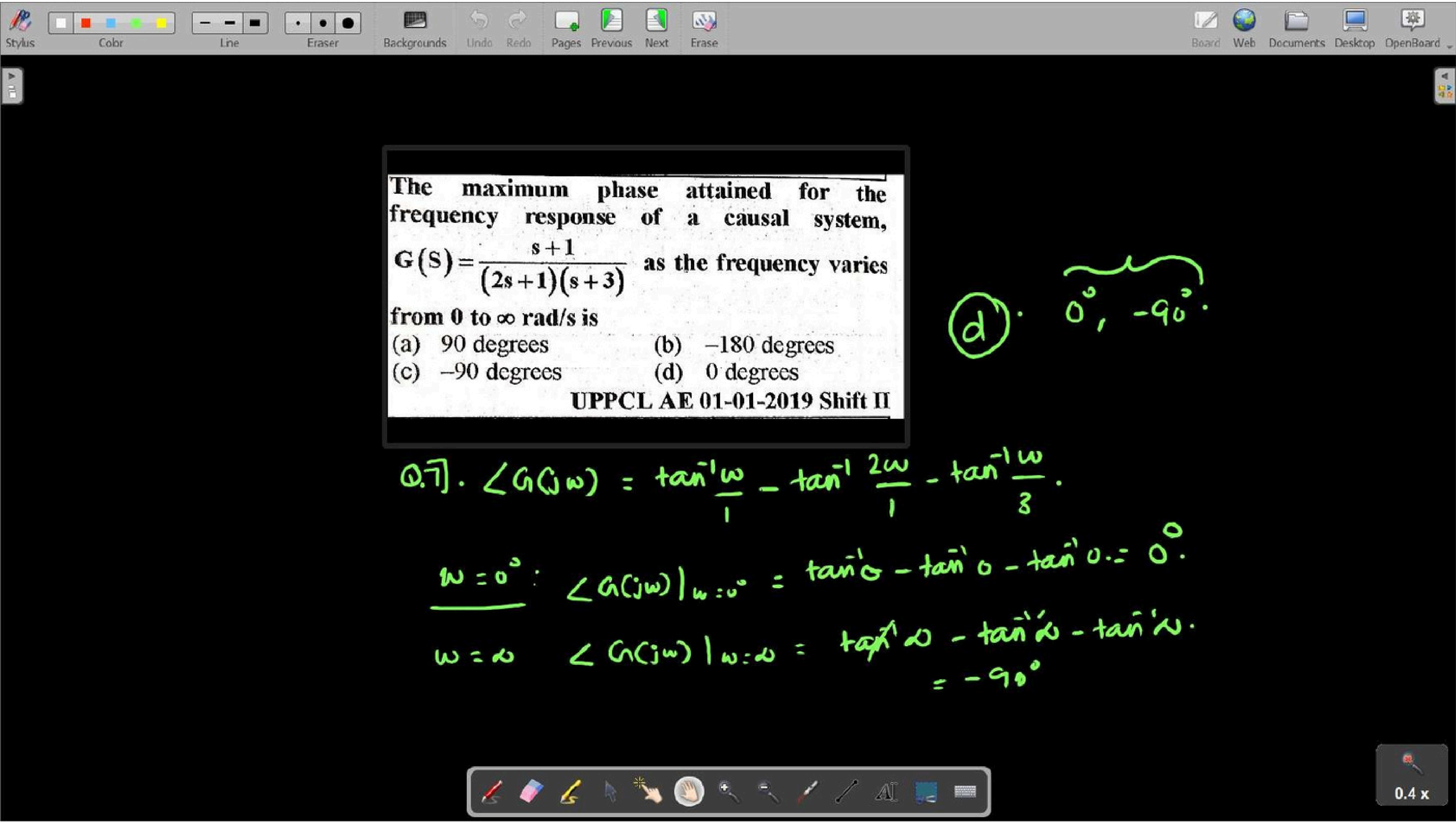
$\underline{\omega = \infty}$:

$\angle G(j\omega) = \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.

$= -90^\circ$.

$0^\circ, -90^\circ$

Full Video Link



The maximum phase attained for the frequency response of a causal system, $G(S)=\frac{s+1}{(2s+1)(s+3)}$ as the frequency varies from 0 to ∞ rad/s is

(a) 90 degrees (b) −180 degrees

(c) −90 degrees (d) 0 degrees

UPPCL AE 01-01-2019 Shift II

(d). $\overbrace{0^\circ, -90^\circ}$.

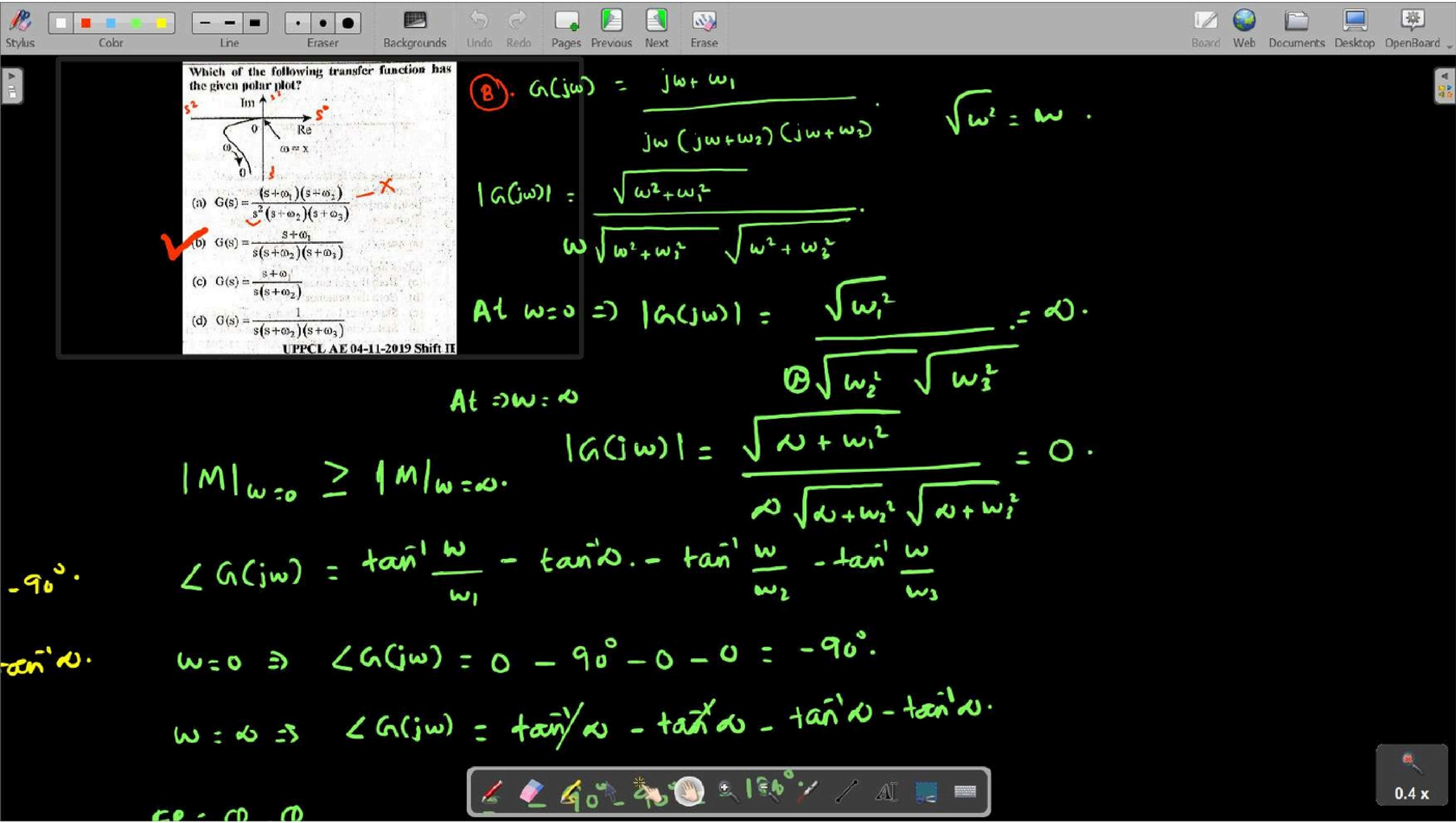
Q.7]. $\angle G(j\omega) = \tan^{-1}\frac{\omega}{1} - \tan^{-1}\frac{2\omega}{1} - \tan^{-1}\frac{\omega}{3}$.

$\underline{\omega = 0^\circ}$: $\angle G(j\omega)|_{\omega=0^\circ} = \tan^{-1}0 - \tan^{-1}0 - \tan^{-1}0 = 0^\circ$.

$\omega = \infty$ $\angle G(j\omega)|_{\omega=\infty} = \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.

$= -90^\circ$

Full Video Link



Which of the following transfer function has the given polar plot?

(a) $G(s) = \dfrac{(s+\omega_1)(s+\omega_2)}{s^2(s+\omega_2)(s+\omega_3)}$ — ✗

✓ (b) $G(s) = \dfrac{s+\omega_1}{s(s+\omega_2)(s+\omega_3)}$

(c) $G(s) = \dfrac{s+\omega_1}{s(s+\omega_2)}$

(d) $G(s) = \dfrac{1}{s(s+\omega_2)(s+\omega_3)}$

UPPCL AE 04-11-2019 Shift II

Ⓑ. $G(j\omega) = \dfrac{j\omega + \omega_1}{j\omega\,(j\omega+\omega_2)(j\omega+\omega_3)}$.

$\sqrt{\omega^2} = \omega$.

$|G(j\omega)| = \dfrac{\sqrt{\omega^2+\omega_1^2}}{\omega\sqrt{\omega^2+\omega_2^2}\sqrt{\omega^2+\omega_3^2}}$.

At $\omega = 0 \Rightarrow |G(j\omega)| = \dfrac{\sqrt{\omega_1^2}}{0\sqrt{\omega_2^2}\sqrt{\omega_3^2}} = \infty$.

At $\Rightarrow \omega = \infty$

$|G(j\omega)| = \dfrac{\sqrt{\infty + \omega_1^2}}{\infty\sqrt{\infty+\omega_2^2}\sqrt{\infty+\omega_3^2}} = 0$.

$|M|_{\omega=0} \geq |M|_{\omega=\infty}$.

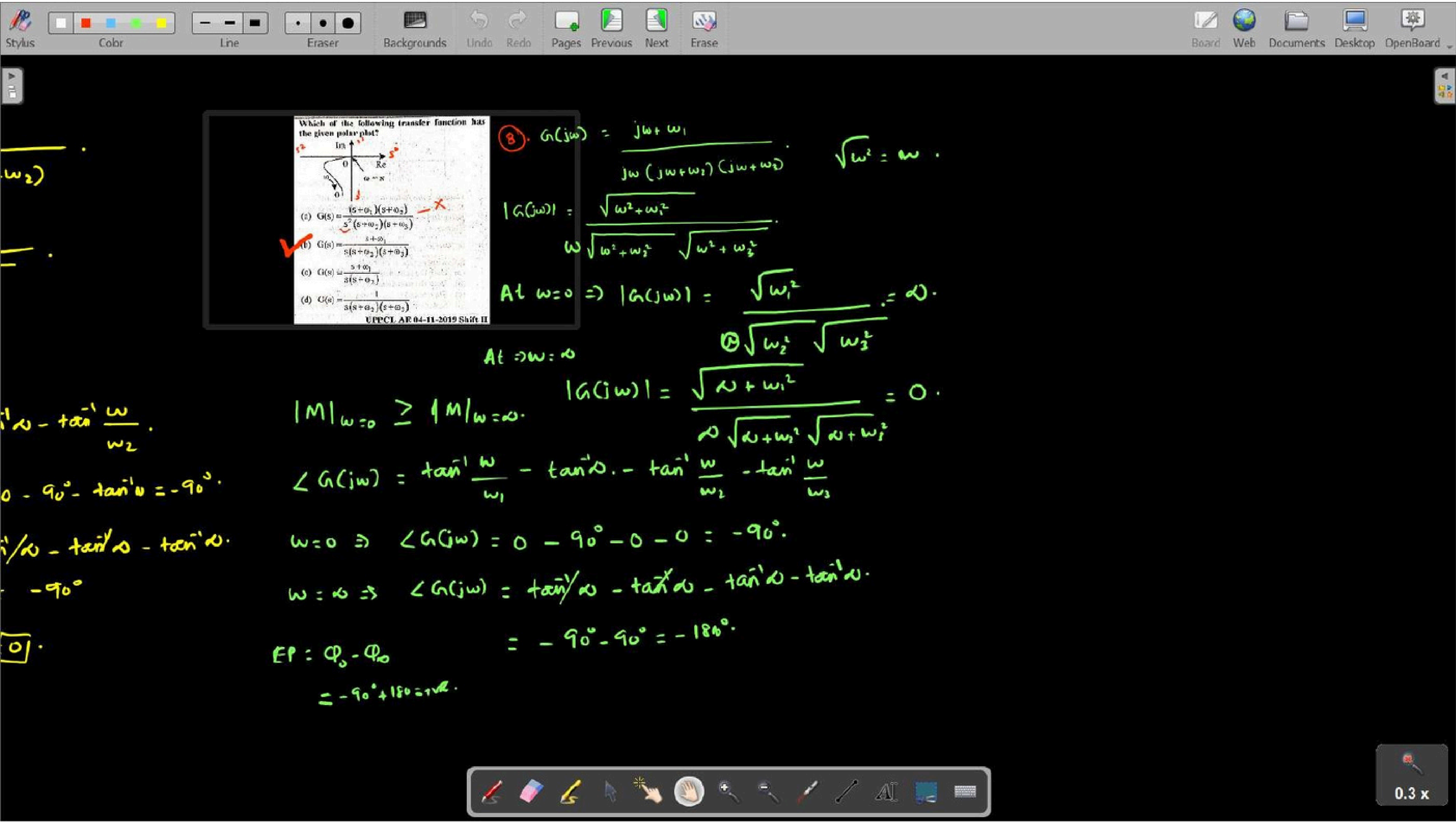
$-90°$.

$\angle G(j\omega) = \tan^{-1}\dfrac{\omega}{\omega_1} - \tan^{-1}\infty. - \tan^{-1}\dfrac{\omega}{\omega_2} - \tan^{-1}\dfrac{\omega}{\omega_3}$

$\tan^{-1}\infty$.

$\omega = 0 \Rightarrow \angle G(j\omega) = 0 - 90° - 0 - 0 = -90°$.

$\omega = \infty \Rightarrow \angle G(j\omega) = \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.



Which of the following transfer function has the given polar plot?

(a) $G(s)=\frac{(s+\omega_1)(s+\omega_2)}{s^2(s+\omega_2)(s+\omega_3)}$ — ×

✓ (b) $G(s)=\frac{s+\omega_1}{s(s+\omega_2)(s+\omega_3)}$

(c) $G(s)=\frac{s+\omega_1}{s(s+\omega_2)}$

(d) $G(s)=\frac{1}{s(s+\omega_2)(s+\omega_3)}$

UPPCL AE 04-11-2019 Shift II

ⓑ. $G(jw) = \frac{jw+w_1}{jw(jw+w_2)(jw+w_3)}$. $\sqrt{w^2} = w$.

$|G(jw)| = \frac{\sqrt{w^2+w_1^2}}{w\sqrt{w^2+w_2^2}\sqrt{w^2+w_3^2}}$.

At $w=0 \Rightarrow |G(jw)| = \frac{\sqrt{w_1^2}}{0\sqrt{w_2^2}\sqrt{w_3^2}} = \infty$.

At $\Rightarrow w=\infty$

$|G(jw)| = \frac{\sqrt{\infty+w_1^2}}{\infty\sqrt{\infty+w_2^2}\sqrt{\infty+w_3^2}} = 0$.

$|M|_{w=0} \geq |M|_{w=\infty}$.

$\angle G(jw) = \tan^{-1}\frac{w}{w_1} - \tan^{-1}\infty. - \tan^{-1}\frac{w}{w_2} - \tan^{-1}\frac{w}{w_3}$

$w=0 \Rightarrow \angle G(jw) = 0 - 90^\circ - 0 - 0 = -90^\circ$.

$w=\infty \Rightarrow \angle G(jw) = \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.

$= -90^\circ - 90^\circ = -180^\circ$.

$EP = \varphi_0 - \varphi_\infty$

$= -90^\circ + 180 = +ve$.

$w_2)$

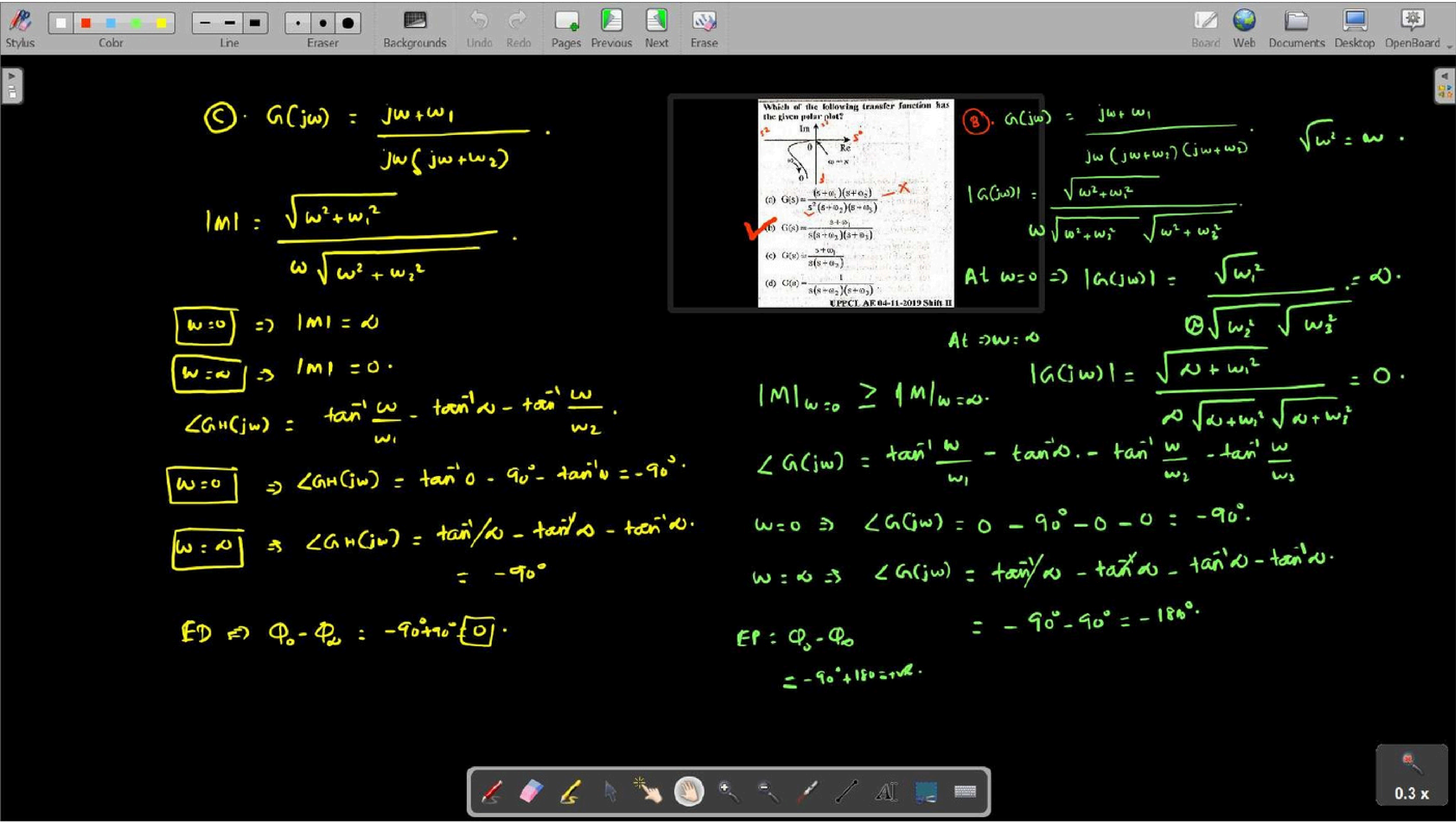
$^{-1}\infty - \tan^{-1}\frac{w}{w_2}$.

$0 - 90^\circ - \tan^{-1}\infty = -90^\circ$.

$^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.

-90°

$\boxed{0}$.



Which of the following transfer function has the given polar plot?

(a) $G(s)=\frac{(s+\omega_1)(s+\omega_2)}{s^2(s+\omega_2)(s+\omega_3)}$ — ✗

✓ (b) $G(s)=\frac{s+\omega_1}{s(s+\omega_2)(s+\omega_3)}$

(c) $G(s)=\frac{s+\omega_1}{s(s+\omega_2)}$

(d) $G(s)=\frac{1}{s(s+\omega_2)(s+\omega_3)}$

UPPCL AE 04-11-2019 Shift II

ⓒ. $G(j\omega) = \frac{j\omega+\omega_1}{j\omega(j\omega+\omega_2)}$.

$|M| = \frac{\sqrt{\omega^2+\omega_1^2}}{\omega\sqrt{\omega^2+\omega_2^2}}$.

$\boxed{\omega=0} \Rightarrow |M| = \infty$

$\boxed{\omega=\infty} \Rightarrow |M| = 0$.

$\angle GH(j\omega) = \tan^{-1}\frac{\omega}{\omega_1} - \tan^{-1}\infty - \tan^{-1}\frac{\omega}{\omega_2}$.

$\boxed{\omega=0} \Rightarrow \angle GH(j\omega) = \tan^{-1}0 - 90° - \tan^{-1}0 = -90°$.

$\boxed{\omega=\infty} \Rightarrow \angle GH(j\omega) = \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.

$= -90°$

ED ⇒ $\phi_0 - \phi_\infty = -90°+90° \boxed{0}$.

⑧. $G(j\omega) = \frac{j\omega+\omega_1}{j\omega(j\omega+\omega_2)(j\omega+\omega_3)}$.

$\sqrt{\omega^2} = \omega$.

$|G(j\omega)| = \frac{\sqrt{\omega^2+\omega_1^2}}{\omega\sqrt{\omega^2+\omega_2^2}\sqrt{\omega^2+\omega_3^2}}$.

At $\omega=0 \Rightarrow |G(j\omega)| = \frac{\sqrt{\omega_1^2}}{0\sqrt{\omega_2^2}\sqrt{\omega_3^2}} = \infty$.

At $\Rightarrow \omega=\infty$

$|G(j\omega)| = \frac{\sqrt{\infty+\omega_1^2}}{\infty\sqrt{\infty+\omega_2^2}\sqrt{\infty+\omega_3^2}} = 0$.

$|M|_{\omega=0} \geq |M|_{\omega=\infty}$.

$\angle G(j\omega) = \tan^{-1}\frac{\omega}{\omega_1} - \tan^{-1}\infty - \tan^{-1}\frac{\omega}{\omega_2} - \tan^{-1}\frac{\omega}{\omega_3}$

$\omega=0 \Rightarrow \angle G(j\omega) = 0 - 90° - 0 - 0 = -90°$.

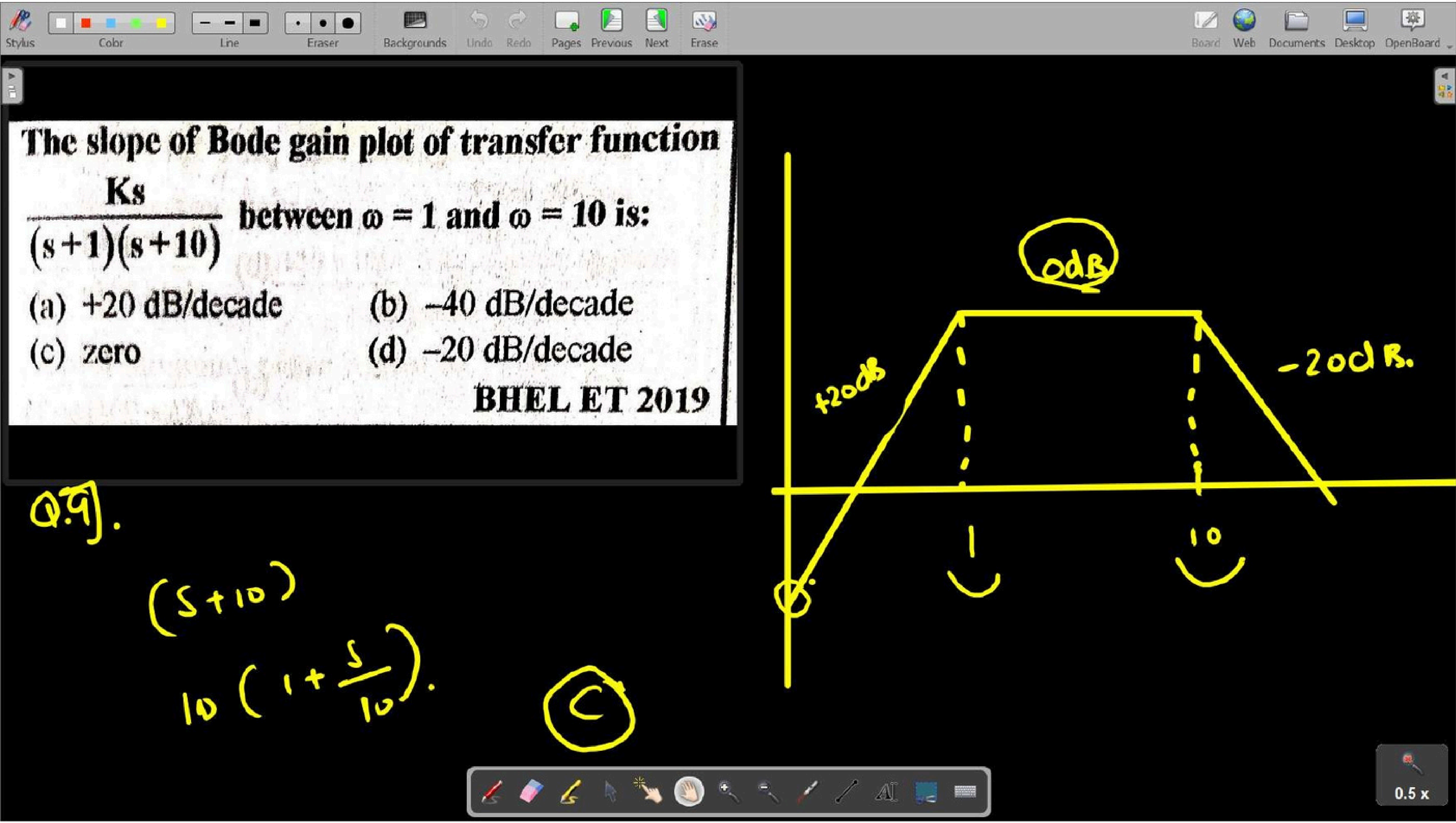
$\omega=\infty \Rightarrow \angle G(j\omega) = \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty - \tan^{-1}\infty$.

$= -90° - 90° = -180°$.

EP : $\phi_0 - \phi_\infty$

$= -90° + 180 = +ve$.

Full Video Link



The slope of Bode gain plot of transfer function $\frac{Ks}{(s+1)(s+10)}$ between ω = 1 and ω = 10 is:

(a) +20 dB/decade (b) –40 dB/decade

(c) zero (d) –20 dB/decade

BHEL ET 2019

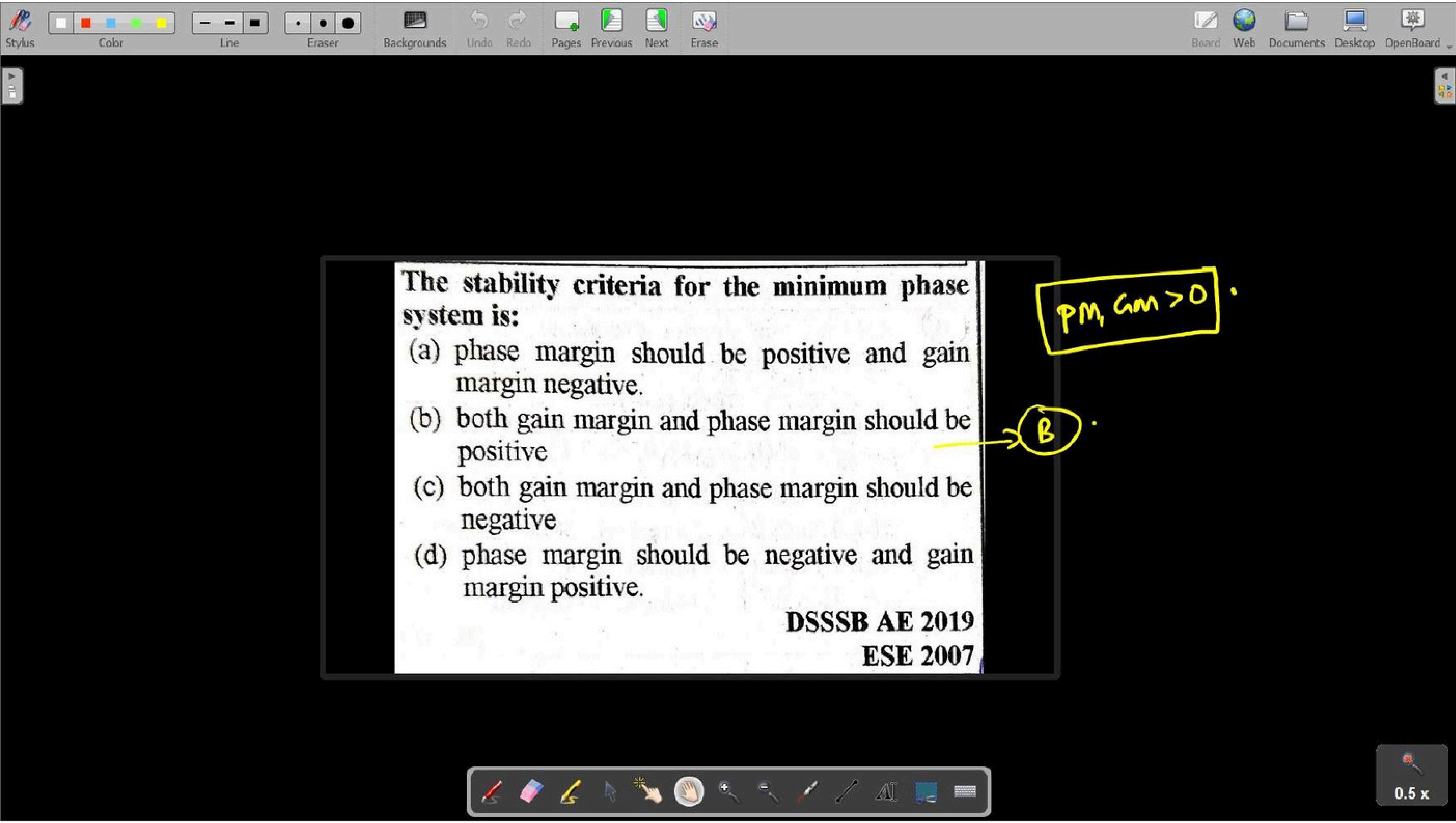
Q.9].

$(s+10)$

$10\left(1+\frac{s}{10}\right).$

Ⓒ

Full Video Link



The stability criteria for the minimum phase system is:

(a) phase margin should be positive and gain margin negative.

(b) both gain margin and phase margin should be positive

(c) both gain margin and phase margin should be negative

(d) phase margin should be negative and gain margin positive.

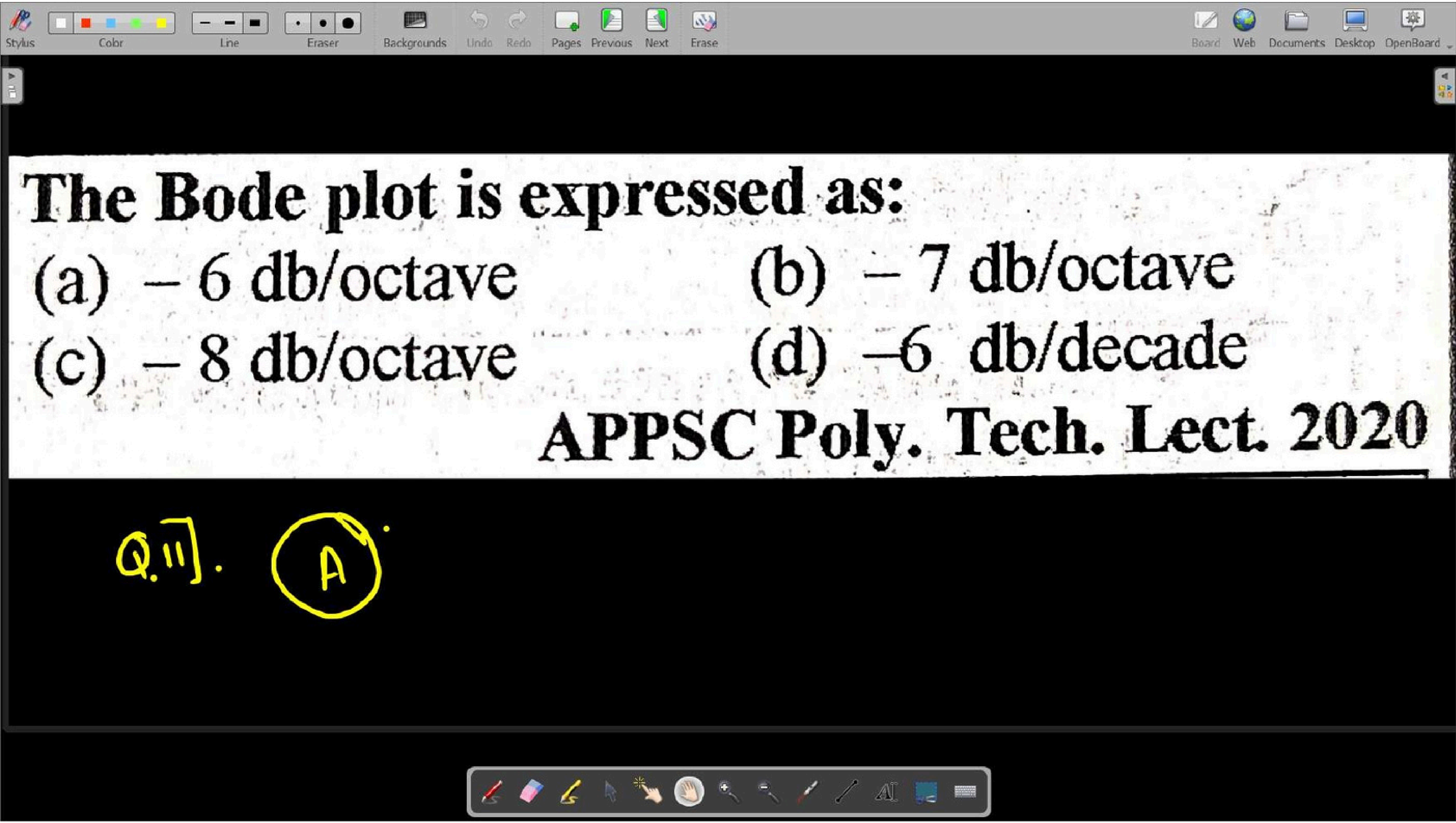
DSSSB AE 2019

ESE 2007

$\boxed{PM, GM > 0}$.

B.

Full Video Link



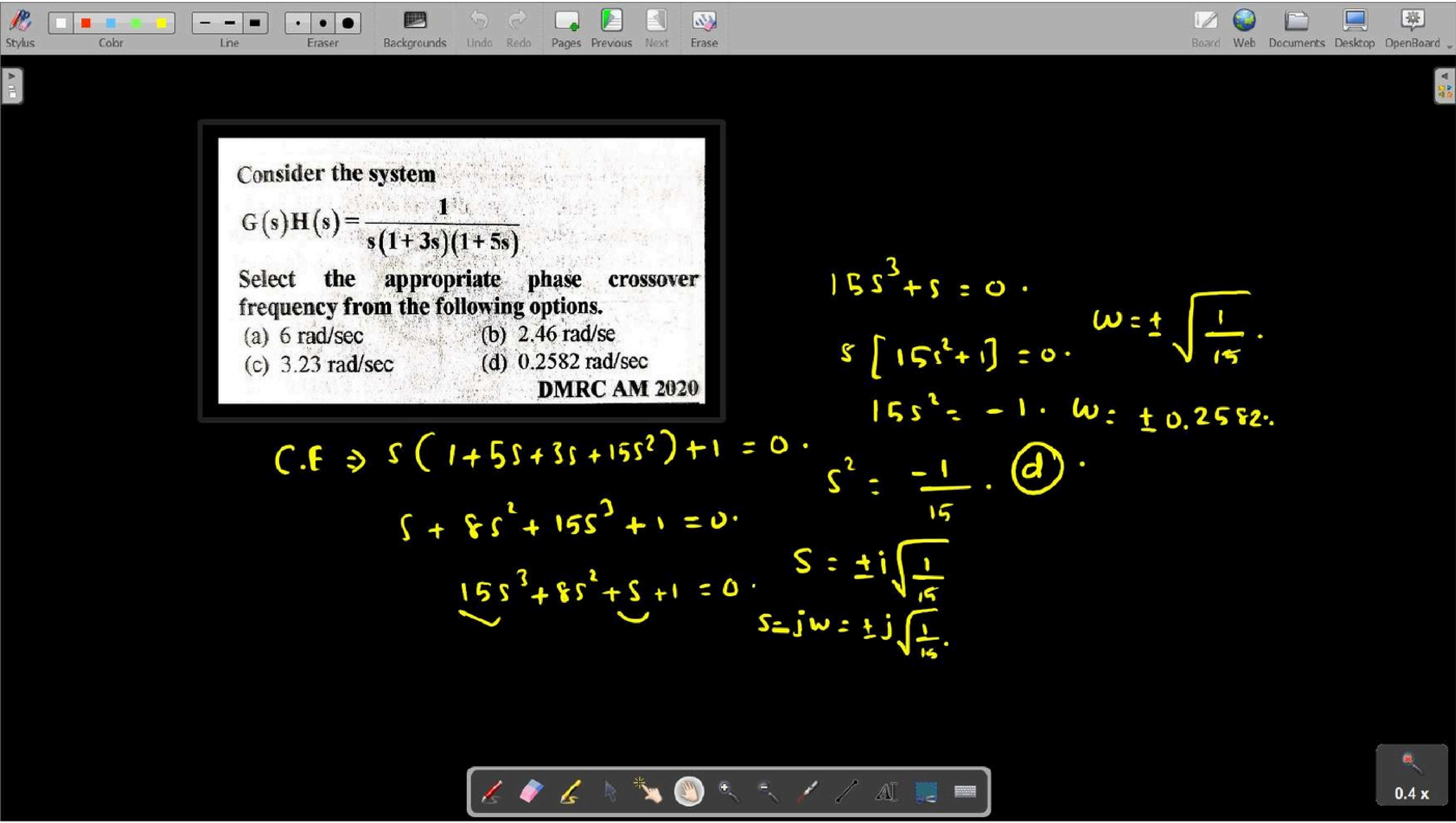
The Bode plot is expressed as:

(a) – 6 db/octave
(b) – 7 db/octave
(c) – 8 db/octave
(d) –6 db/decade

APPSC Poly. Tech. Lect. 2020

Q.11]. Ⓐ

Full Video Link



Consider the system

$$G(s)H(s)=\frac{1}{s(1+3s)(1+5s)}$$

Select the appropriate phase crossover frequency from the following options.

(a) 6 rad/sec (b) 2.46 rad/se

(c) 3.23 rad/sec (d) 0.2582 rad/sec

DMRC AM 2020

$$C.E \Rightarrow s(1+5s+3s+15s^2)+1=0.$$

$$s+8s^2+15s^3+1=0.$$

$$\underbrace{15s^3}+8s^2+\underbrace{s}+1=0.$$

$$15s^3+s=0.$$

$$s[15s^2+1]=0.$$

$$15s^2=-1.$$

$$s^2=\frac{-1}{15}.$$

$$S=\pm i\sqrt{\frac{1}{15}}$$

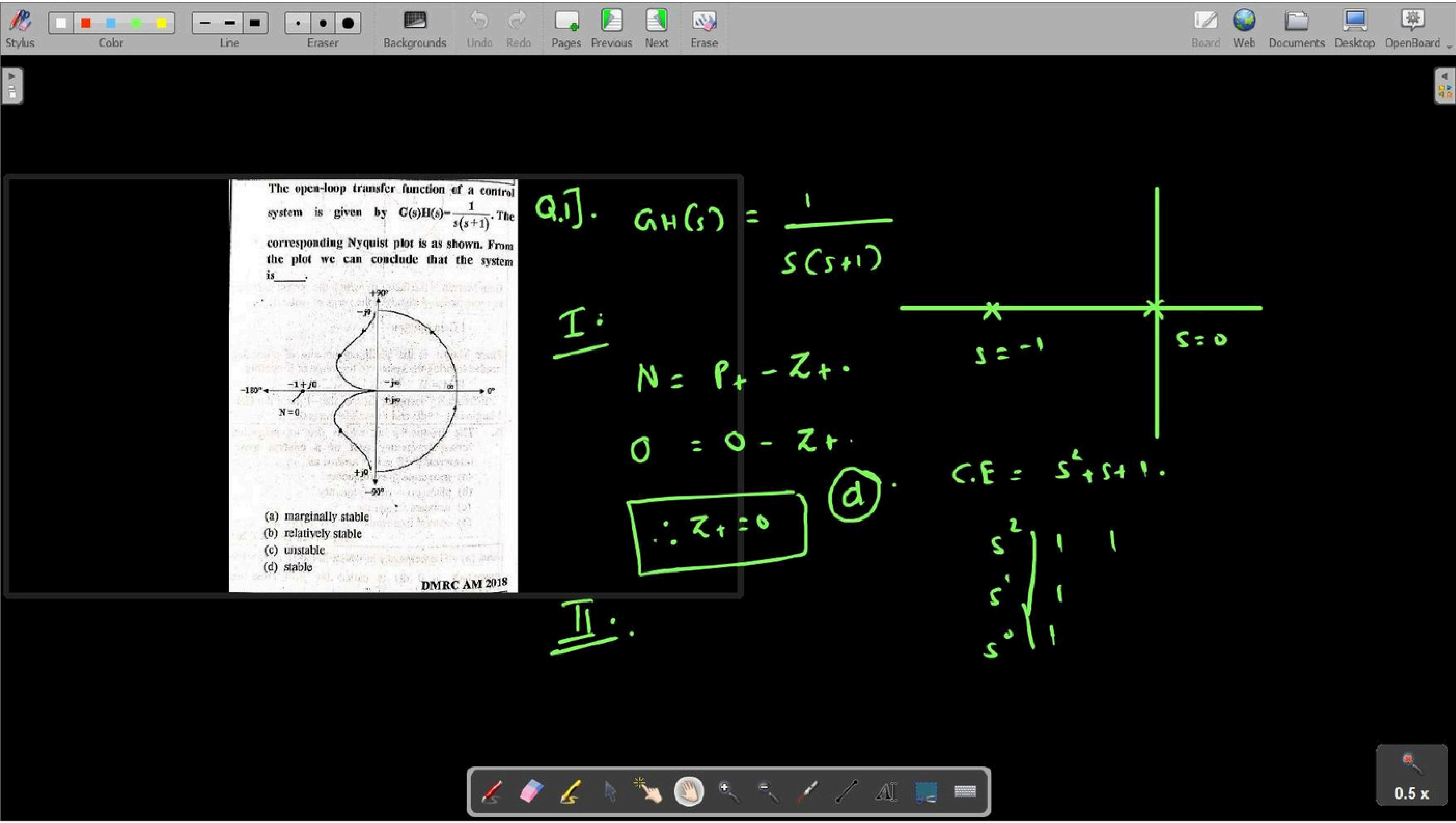
$$s=jw=\pm j\sqrt{\frac{1}{15}}.$$

$$\omega=\pm\sqrt{\frac{1}{15}}.$$

$$\omega=\pm 0.2582.$$

ⓓ.

Full Video Link



The open-loop transfer function of a control system is given by $G(s)H(s) = \frac{1}{s(s+1)}$. The corresponding Nyquist plot is as shown. From the plot we can conclude that the system is_____.

(a) marginally stable
(b) relatively stable
(c) unstable
(d) stable

DMRC AM 2018

Q.1]. $GH(s) = \frac{1}{s(s+1)}$

I:

$N = P_+ - Z_+$.

$0 = 0 - Z_+$.

$\boxed{\therefore Z_+ = 0}$

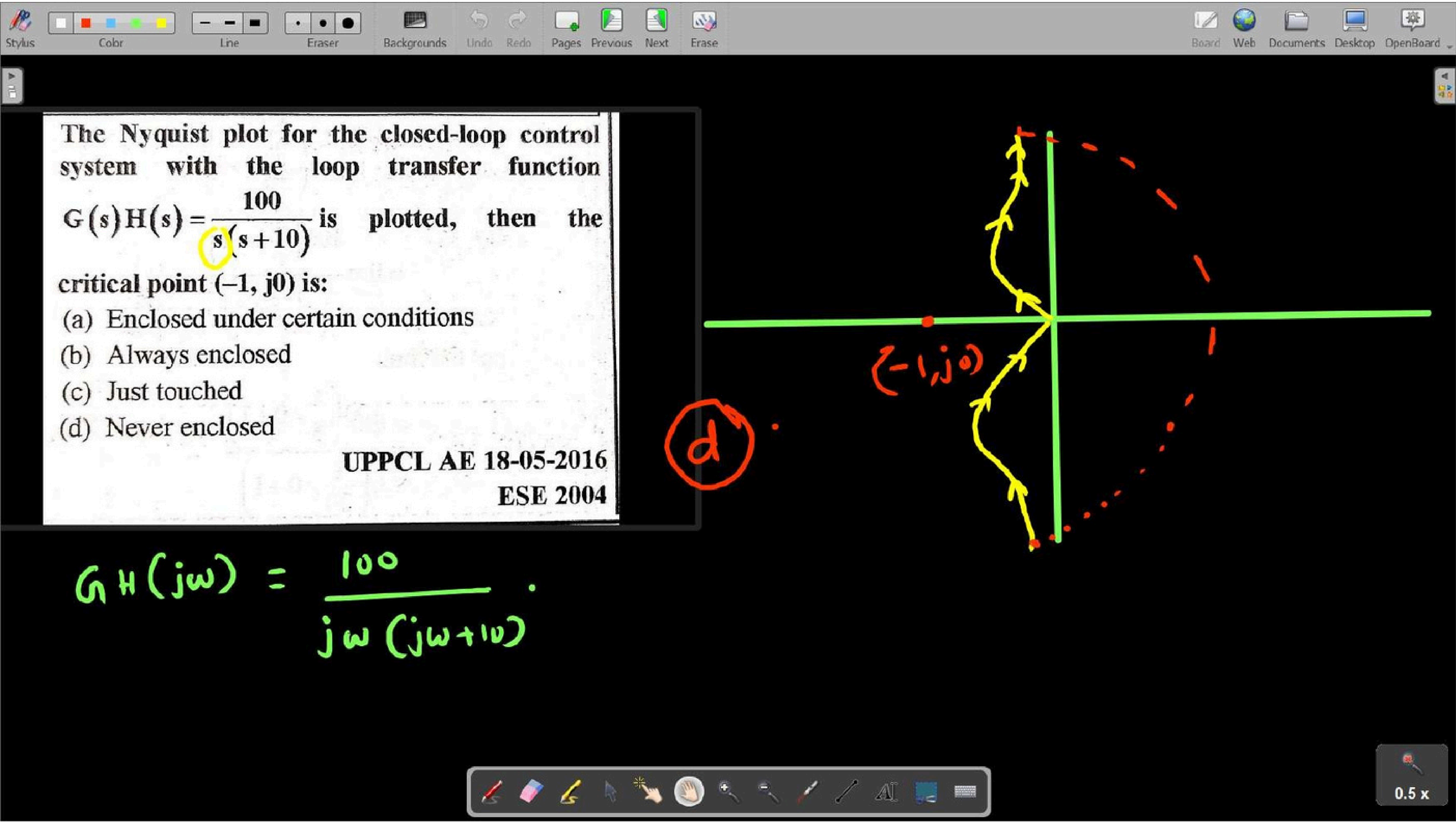
ⓓ.

C.E = $s^2 + s + 1$.

$$\begin{array}{c|cc} s^2 & 1 & 1 \\ s^1 & 1 & \\ s^0 & 1 & \end{array}$$

II.

Full Video Link



The Nyquist plot for the closed-loop control system with the loop transfer function $G(s)H(s)=\frac{100}{s(s+10)}$ is plotted, then the critical point (–1, j0) is:

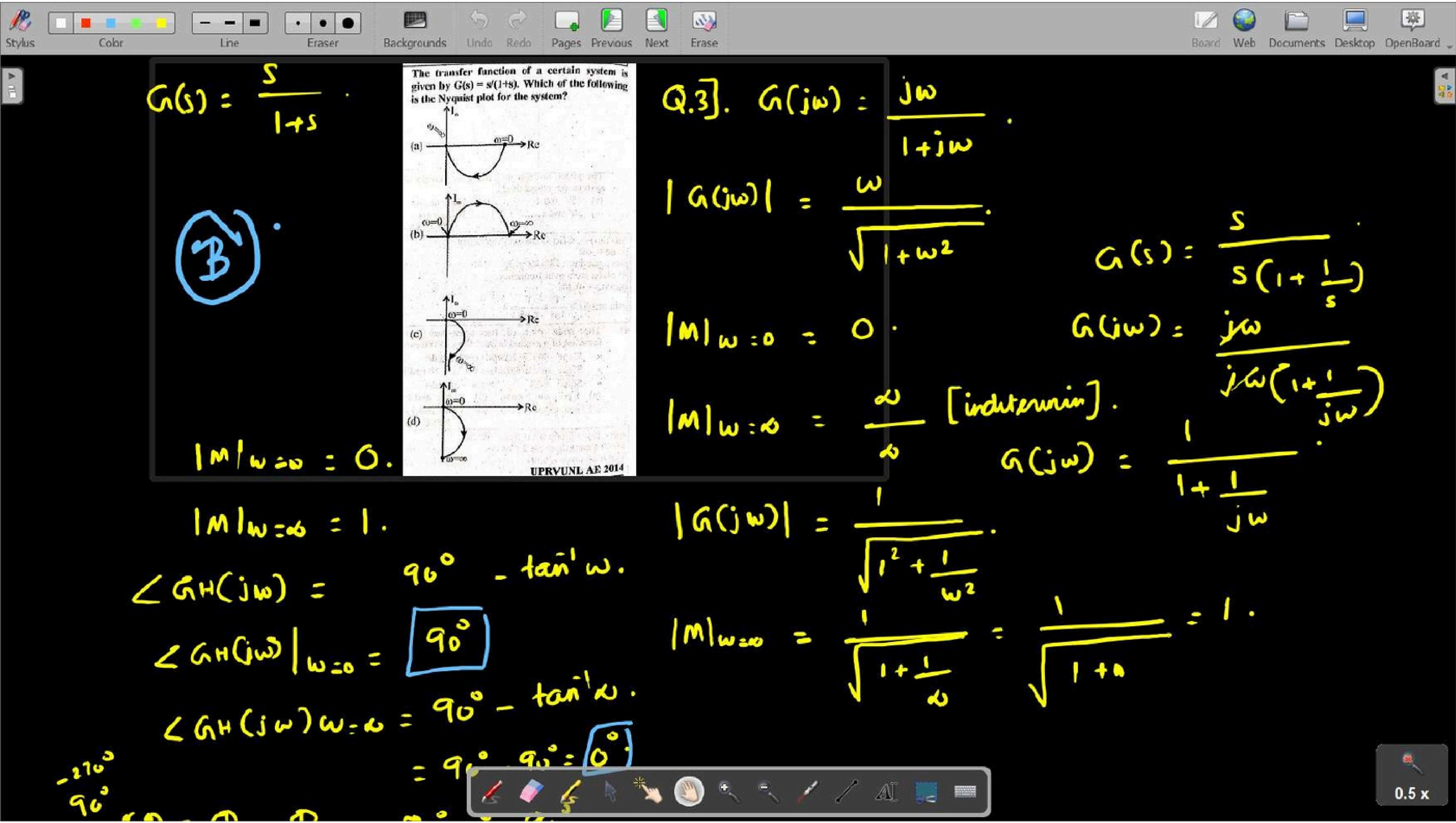
(a) Enclosed under certain conditions
(b) Always enclosed
(c) Just touched
(d) Never enclosed

UPPCL AE 18-05-2016
ESE 2004

ⓓ

$$GH(j\omega) = \frac{100}{j\omega(j\omega+10)}$$

Full Video Link



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

B.

$|M|_{w=0} = 0.$

The transfer function of a certain system is given by G(s) = s/(1+s). Which of the following is the Nyquist plot for the system?

(a)

(b)

(c)

(d)

UPRVUNL AE 2014

Q.3]. $G(j\omega) = \frac{j\omega}{1+j\omega}$.

$|G(j\omega)| = \frac{\omega}{\sqrt{1+\omega^2}}$.

$|M|_{\omega=0} = 0$.

$|M|_{\omega=\infty} = \frac{\infty}{\infty}$ [indeterminate].

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

$G(j\omega) = \frac{j\omega}{j\omega(1+\frac{1}{j\omega})}$.

$G(j\omega) = \frac{1}{1+\frac{1}{j\omega}}$

$|G(j\omega)| = \frac{1}{\sqrt{1^2+\frac{1}{\omega^2}}}$.

$|M|_{w=\infty} = \frac{1}{\sqrt{1+\frac{1}{\infty}}} = \frac{1}{\sqrt{1+0}} = 1$.

$|M|_{w=\infty} = 1.$

$\angle GH(j\omega) = 90^\circ - \tan^{-1}\omega.$

$\angle GH(j\omega)|_{\omega=0} = \boxed{90^\circ}$

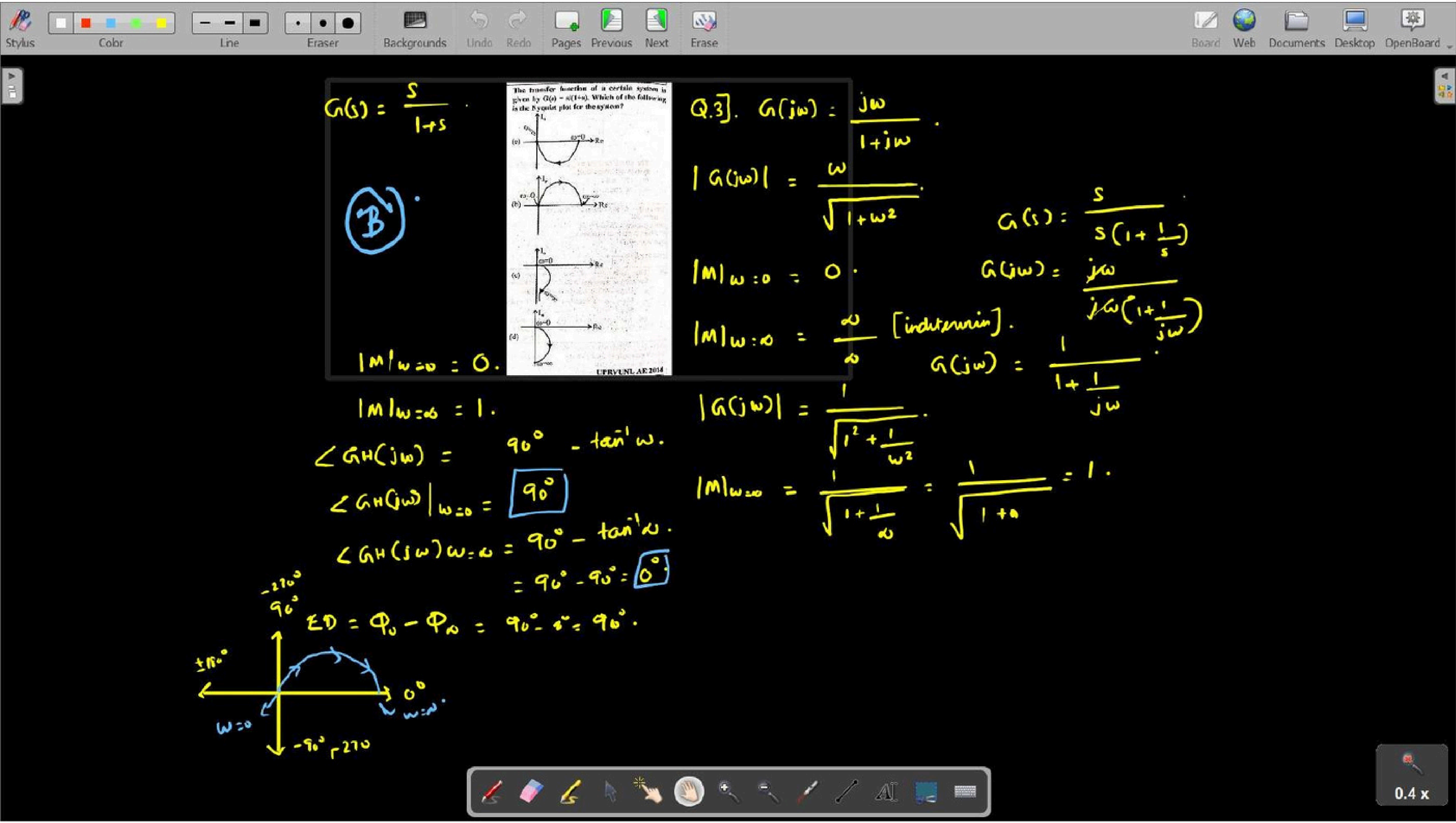
$\angle GH(j\omega)_{\omega=\infty} = 90^\circ - \tan^{-1}\infty.$

$= 90^\circ - 90^\circ = \boxed{0^\circ}$

-270°

90°

Full Video Link



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

$\textcircled{B}$.

The transfer function of a certain system is given by $G(s) = s/(1+s)$. Which of the following is the Nyquist plot for the system?

UPRVUNL AE 2014

$|M|_{\omega=0} : 0.$

$|M|_{\omega=\infty} : 1.$

$\angle GH(j\omega) = 90^\circ - \tan^{-1}\omega.$

$\angle GH(j\omega)|_{\omega=0} = \boxed{90^\circ}$

$\angle GH(j\omega)_{\omega=\infty} = 90^\circ - \tan^{-1}\infty.$

$= 90^\circ - 90^\circ = \boxed{0^\circ}$

$ED = \phi_0 - \phi_\infty = 90^\circ - 0^\circ = 90^\circ.$

Q.3]. $G(j\omega) : \frac{j\omega}{1+j\omega}$.

$|G(j\omega)| = \frac{\omega}{\sqrt{1+\omega^2}}$.

$|M|_{\omega:0} = 0.$

$|M|_{\omega:\infty} = \frac{\infty}{\infty}$ [indeterminant].

$|G(j\omega)| = \frac{1}{\sqrt{1^2 + \frac{1}{\omega^2}}}$.

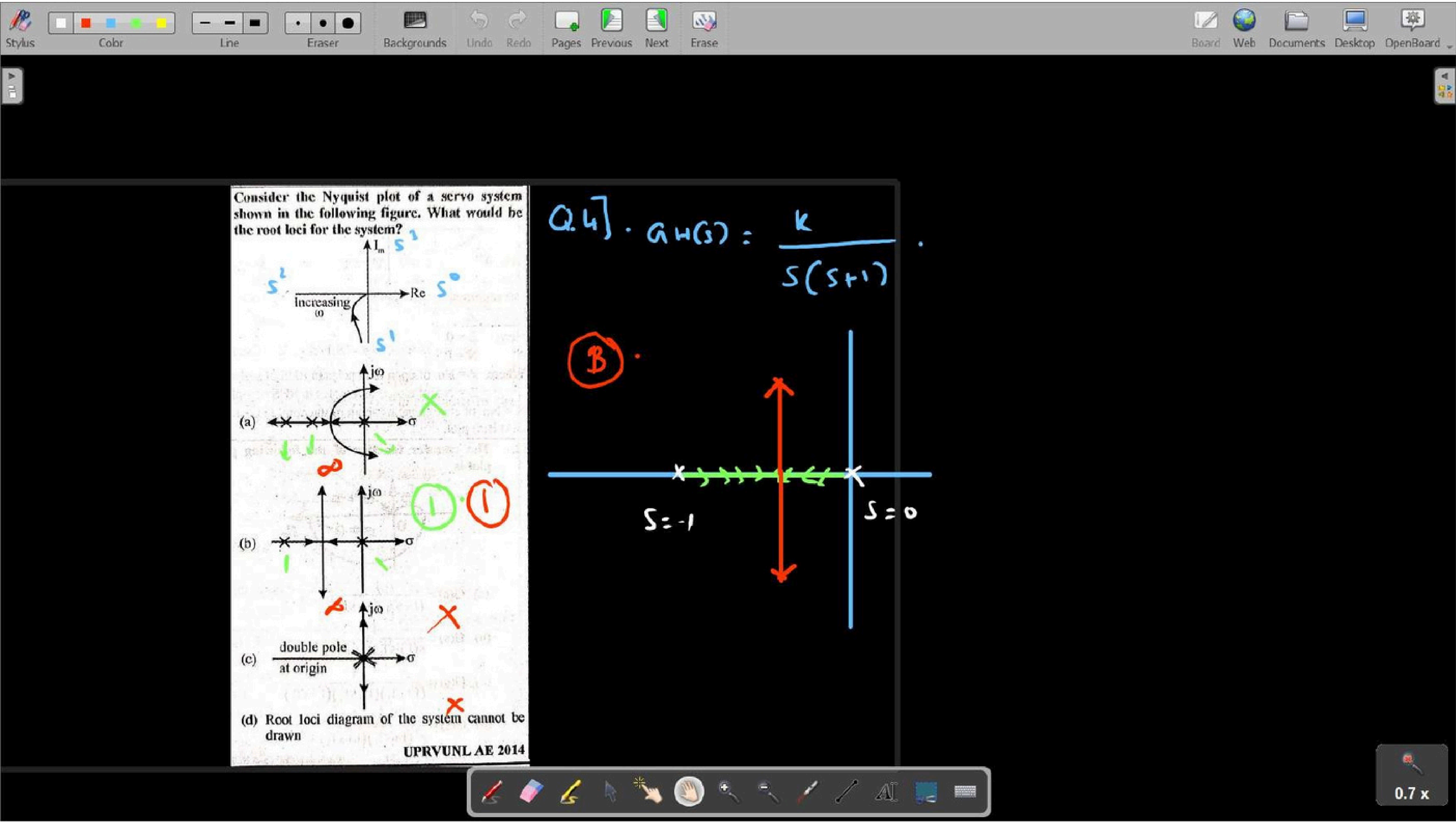
$|M|_{\omega=\infty} = \frac{1}{\sqrt{1+\frac{1}{\infty}}} = \frac{1}{\sqrt{1+0}} = 1.$

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

$G(j\omega) = \frac{j\omega}{j\omega(1+\frac{1}{j\omega})}$

$G(j\omega) = \frac{1}{1+\frac{1}{j\omega}}$.

Full Video Link



Consider the Nyquist plot of a servo system shown in the following figure. What would be the root loci for the system?

(a)

(b)

(c)

(d) Root loci diagram of the system cannot be drawn

UPRVUNL AE 2014

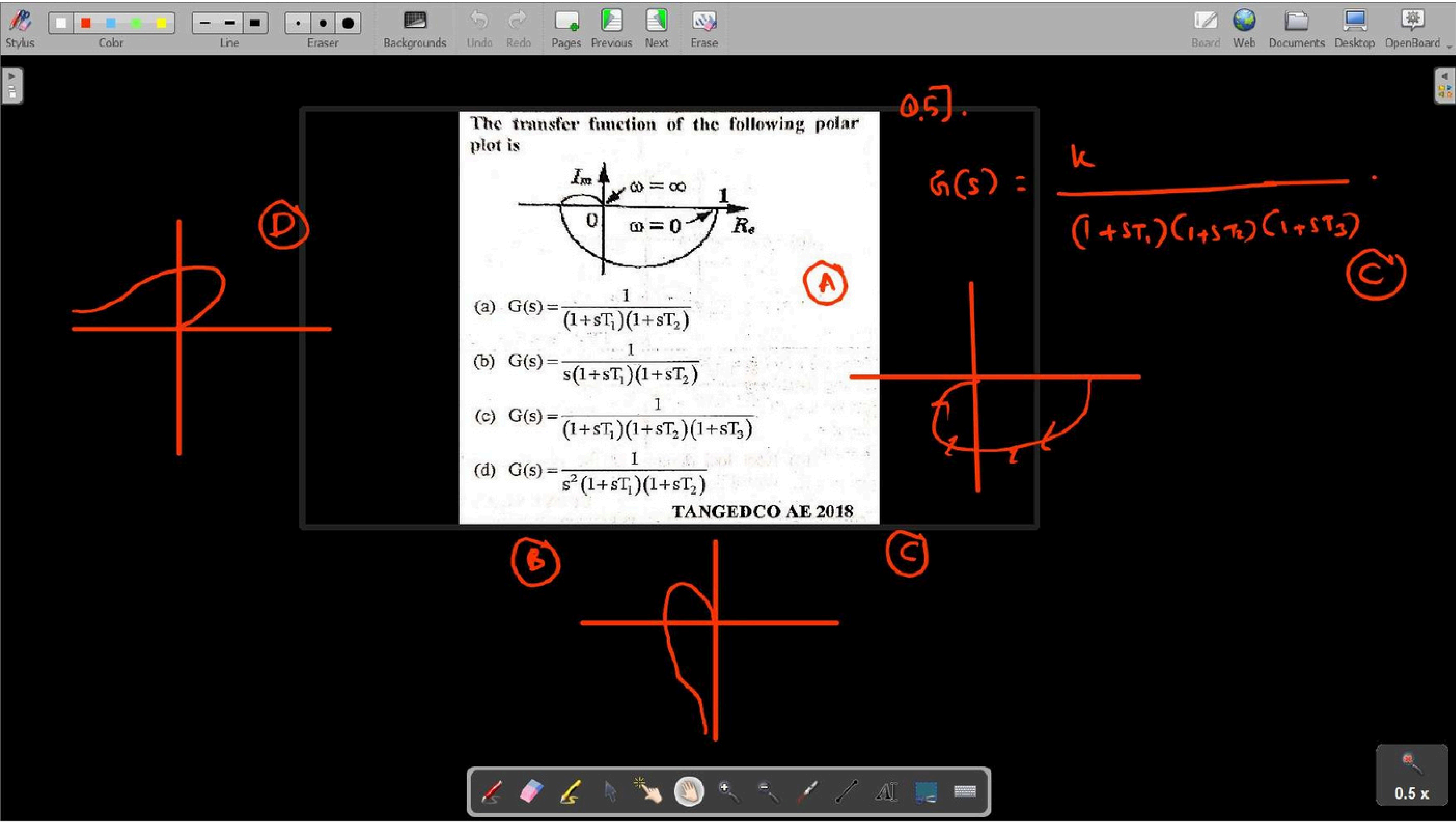
Q.4]. $GH(s) = \frac{K}{s(s+1)}$.

B.

$s=-1$

$s=0$

Full Video Link



The transfer function of the following polar plot is

(a) $G(s) = \dfrac{1}{(1+sT_1)(1+sT_2)}$

(b) $G(s) = \dfrac{1}{s(1+sT_1)(1+sT_2)}$

(c) $G(s) = \dfrac{1}{(1+sT_1)(1+sT_2)(1+sT_3)}$

(d) $G(s) = \dfrac{1}{s^2(1+sT_1)(1+sT_2)}$

TANGEDCO AE 2018

0.5].

$$G(s) = \frac{k}{(1+sT_1)(1+sT_2)(1+sT_3)}$$

Ⓒ

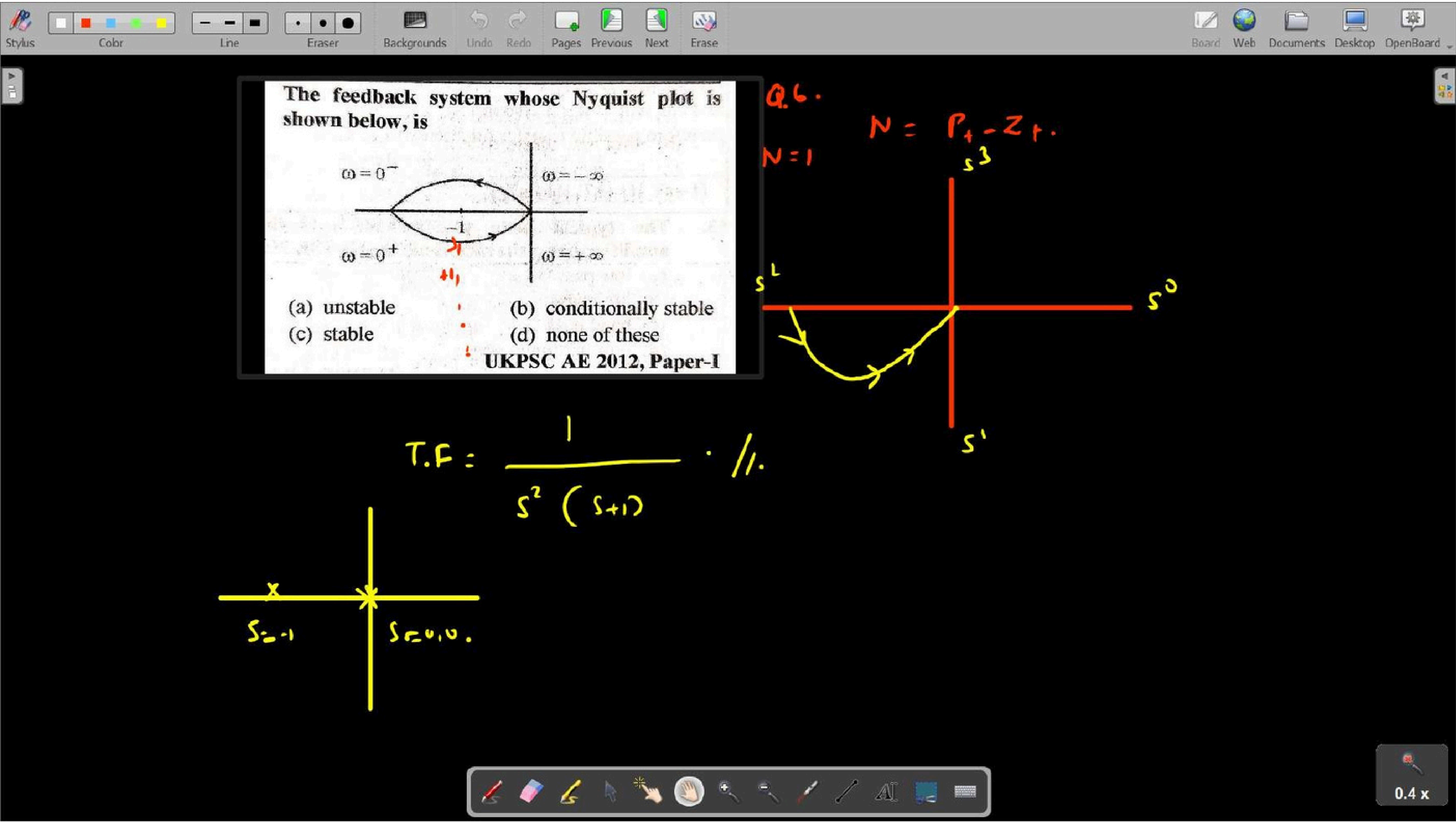
Ⓓ

Ⓐ

Ⓑ

Ⓒ

Full Video Link



The feedback system whose Nyquist plot is shown below, is

(a) unstable
(b) conditionally stable
(c) stable
(d) none of these

UKPSC AE 2012, Paper-I

Q.6.

$N = P_+ - Z_+$.

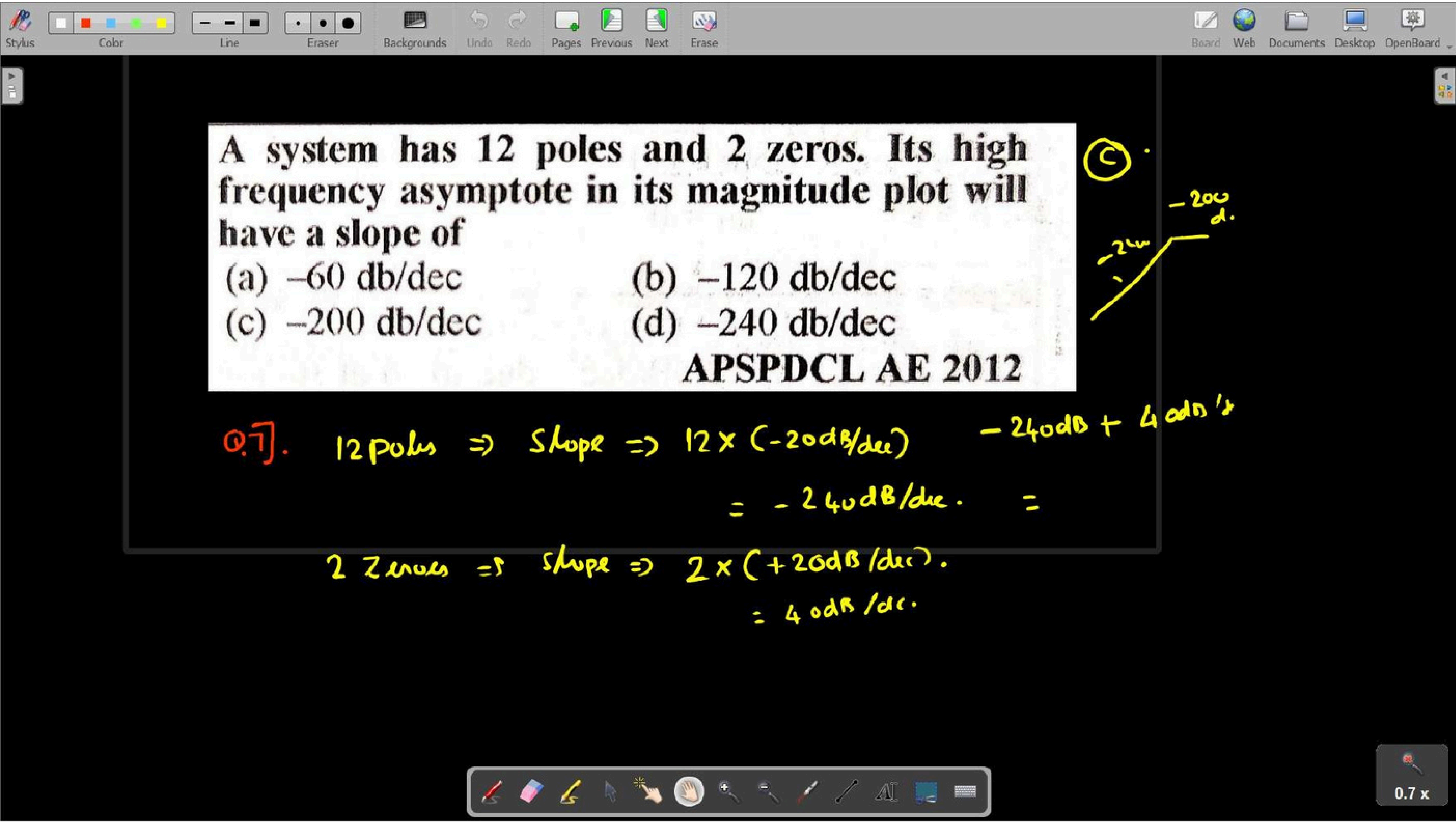
$N = 1$

$$T.F = \frac{1}{s^2(s+1)} \cdot //.$$

$S = -1$

$S = 0, 0.$

Full Video Link



A system has 12 poles and 2 zeros. Its high frequency asymptote in its magnitude plot will have a slope of

(a) –60 db/dec (b) –120 db/dec

(c) –200 db/dec (d) –240 db/dec

APSPDCL AE 2012

ⓒ.

-200 d.

-240

Q.7]. 12 Poles ⇒ Slope ⇒ $12 \times (-20dB/dec)$

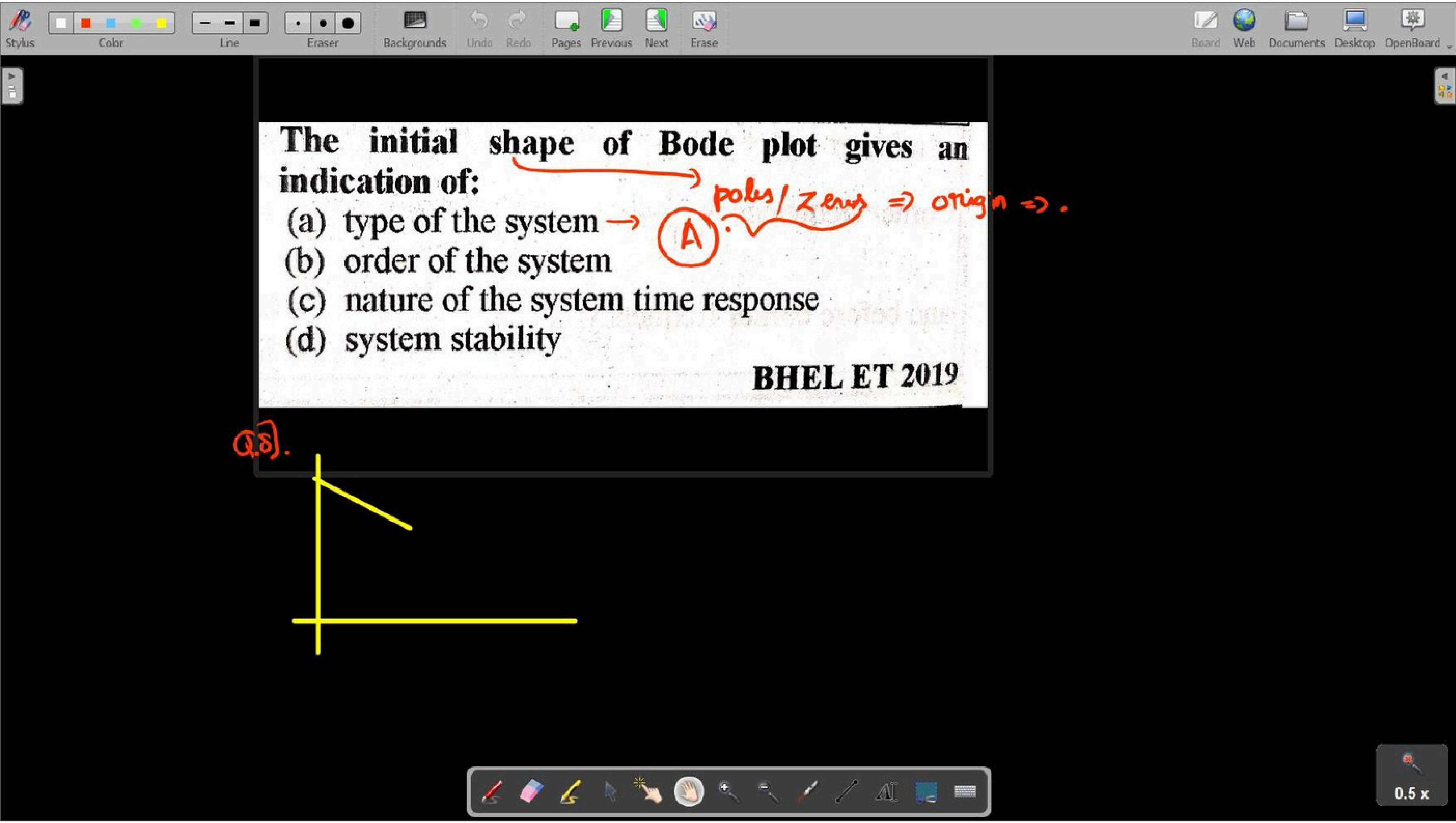
$= -240dB/dec.$ =

$-240dB + 40dB$'s

2 Zeroes ⇒ slope ⇒ $2 \times (+20dB/dec).$

$= 40dB/dc.$

Full Video Link



The initial shape of Bode plot gives an indication of:

(a) type of the system → (A).

(b) order of the system

(c) nature of the system time response

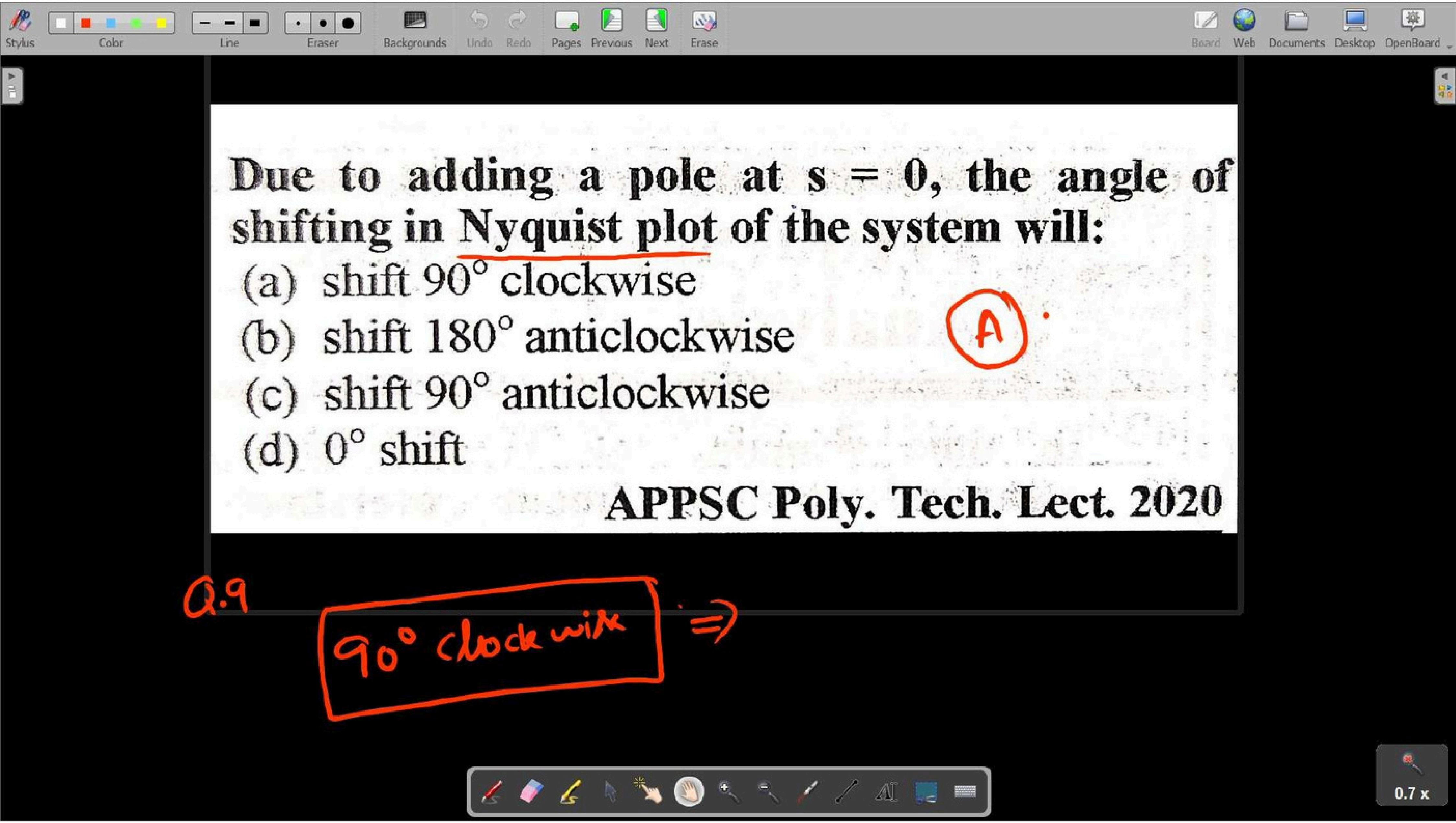
(d) system stability

BHEL ET 2019

poles/zeros ⇒ origin ⇒ .

Q.8].

Full Video Link



Due to adding a pole at s = 0, the angle of shifting in Nyquist plot of the system will:

(a) shift 90° clockwise

(b) shift 180° anticlockwise

(c) shift 90° anticlockwise

(d) 0° shift

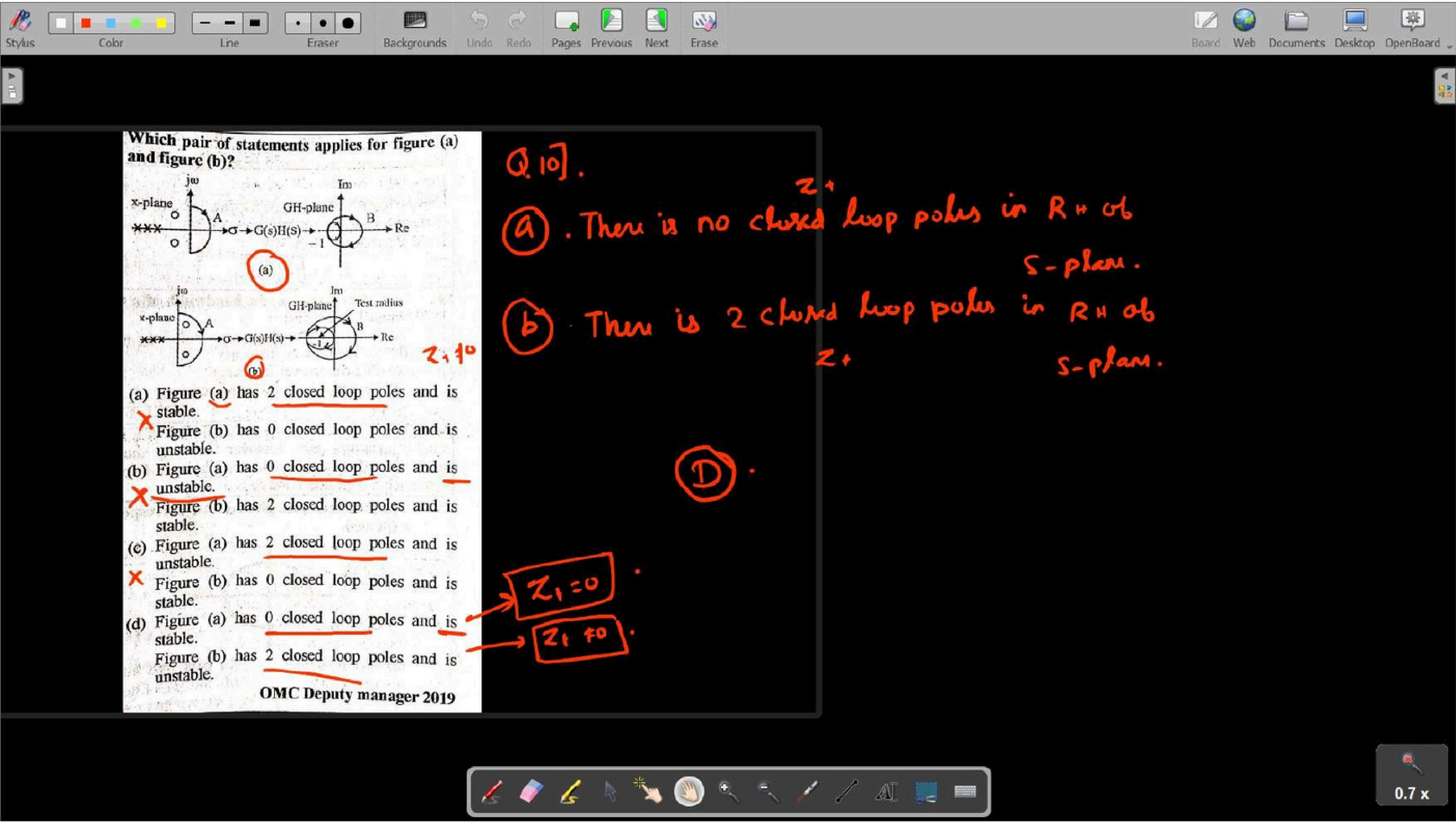
Ⓐ

APPSC Poly. Tech. Lect. 2020

Q.9

$\boxed{90^\circ \text{ clock wise}} \Rightarrow$

Full Video Link



Which pair of statements applies for figure (a) and figure (b)?

$Z_+ \neq 0$

(a) Figure (a) has 2 closed loop poles and is stable.
✗ Figure (b) has 0 closed loop poles and is unstable.

(b) Figure (a) has 0 closed loop poles and is unstable.
✗ Figure (b) has 2 closed loop poles and is stable.

(c) Figure (a) has 2 closed loop poles and is unstable.
✗ Figure (b) has 0 closed loop poles and is stable.

(d) Figure (a) has 0 closed loop poles and is stable.
Figure (b) has 2 closed loop poles and is unstable.

OMC Deputy manager 2019

Q 10].

(a). There is no closed loop poles in RH ob S-plane. Z_+

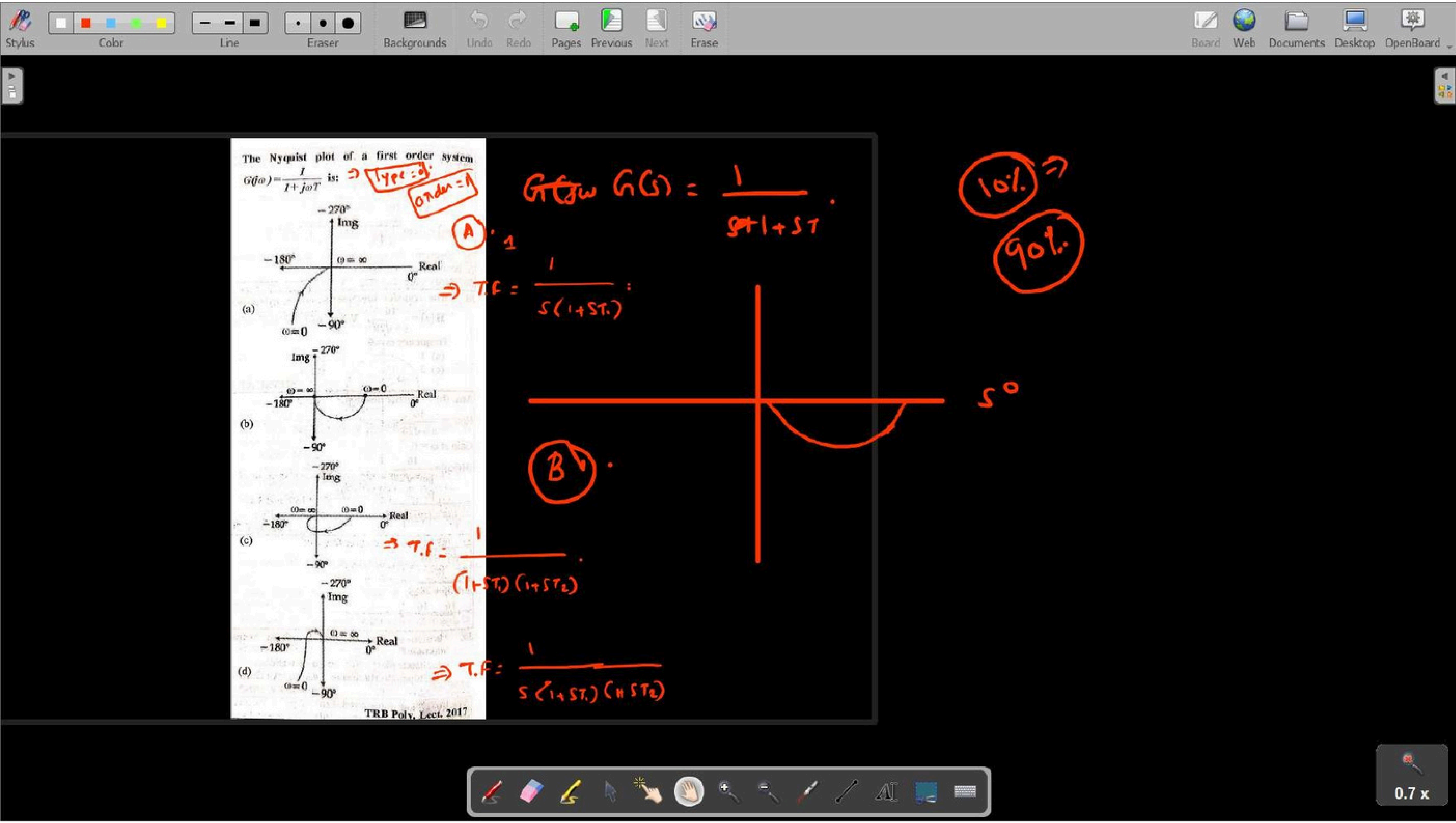
(b). There is 2 closed loop poles in RH ob S-plane. Z_+

(D).

$\boxed{Z_1 = 0}$.

$\boxed{Z_1 \neq 0}$.

Full Video Link



The Nyquist plot of a first order system $G(j\omega) = \frac{1}{1+j\omega T}$ is: ⇒ Type = 0. Order = 1

(a)

(b)

(c)

(d)

TRB Poly. Lect. 2017

$\cancel{G(j\omega)}$ $G(s) = \frac{1}{\cancel{s+}1+sT}$.

(A). 1

$\Rightarrow T.F = \frac{1}{s(1+sT_1)}$.

(B).

$\Rightarrow T.F = \frac{1}{(1+sT_1)(1+sT_2)}$.

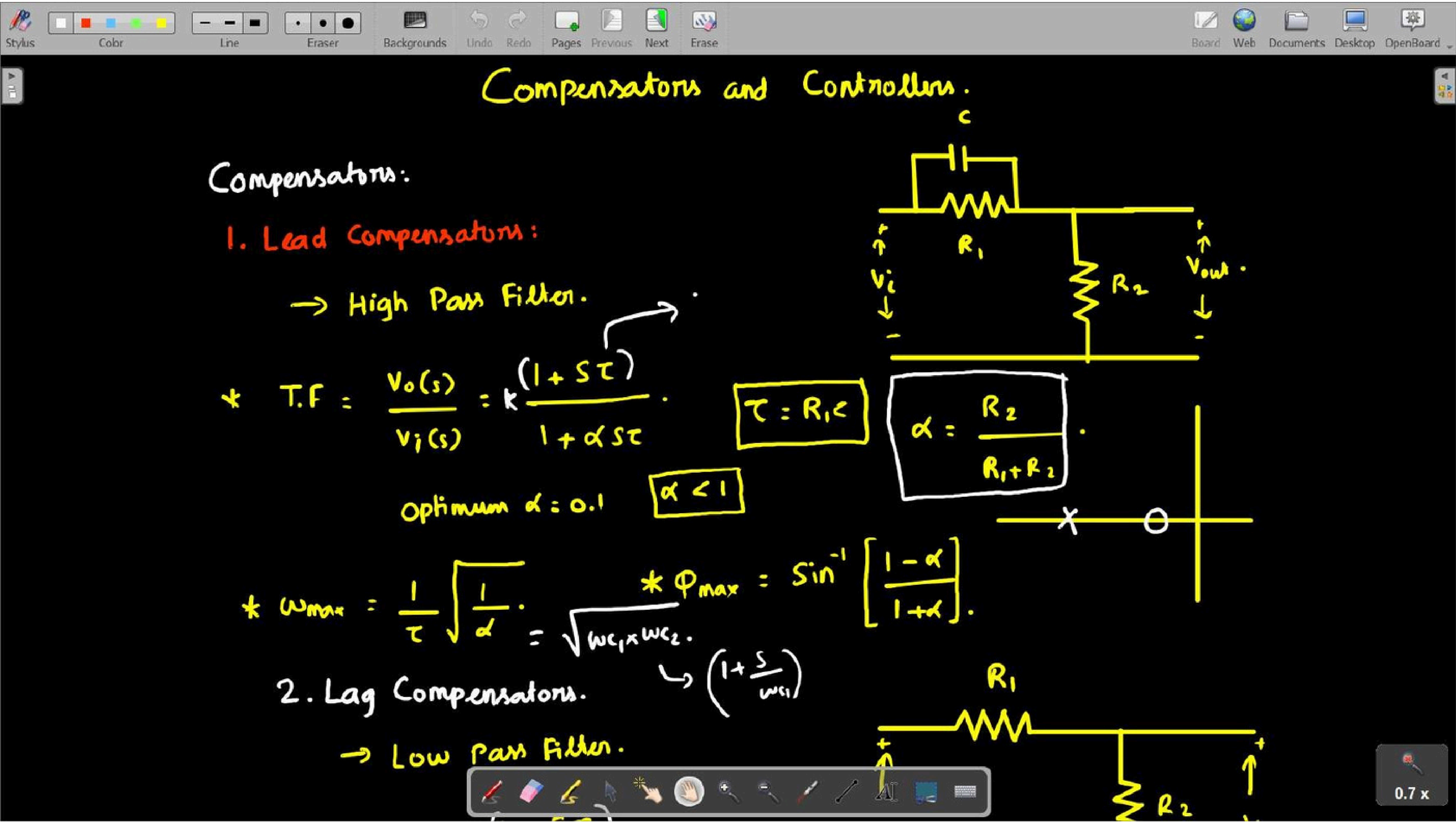
$\Rightarrow T.F = \frac{1}{s(1+sT_1)(1+sT_2)}$

10% ⇒

90%

5°

Full Video Link



Compensators and Controllers.

Compensators:

1. Lead Compensators:

→ High Pass Filter.

$$* \quad T.F = \frac{V_o(s)}{V_i(s)} = k\frac{(1+s\tau)}{1+\alpha s\tau}.$$

$$\boxed{\tau = R_1 C} \qquad \boxed{\alpha = \frac{R_2}{R_1+R_2}}.$$

$$\boxed{\alpha < 1}$$

optimum $\alpha = 0.1$

$$* \quad \omega_{max} = \frac{1}{\tau}\sqrt{\frac{1}{\alpha}}. = \sqrt{\omega c_1 \times \omega c_2}.$$

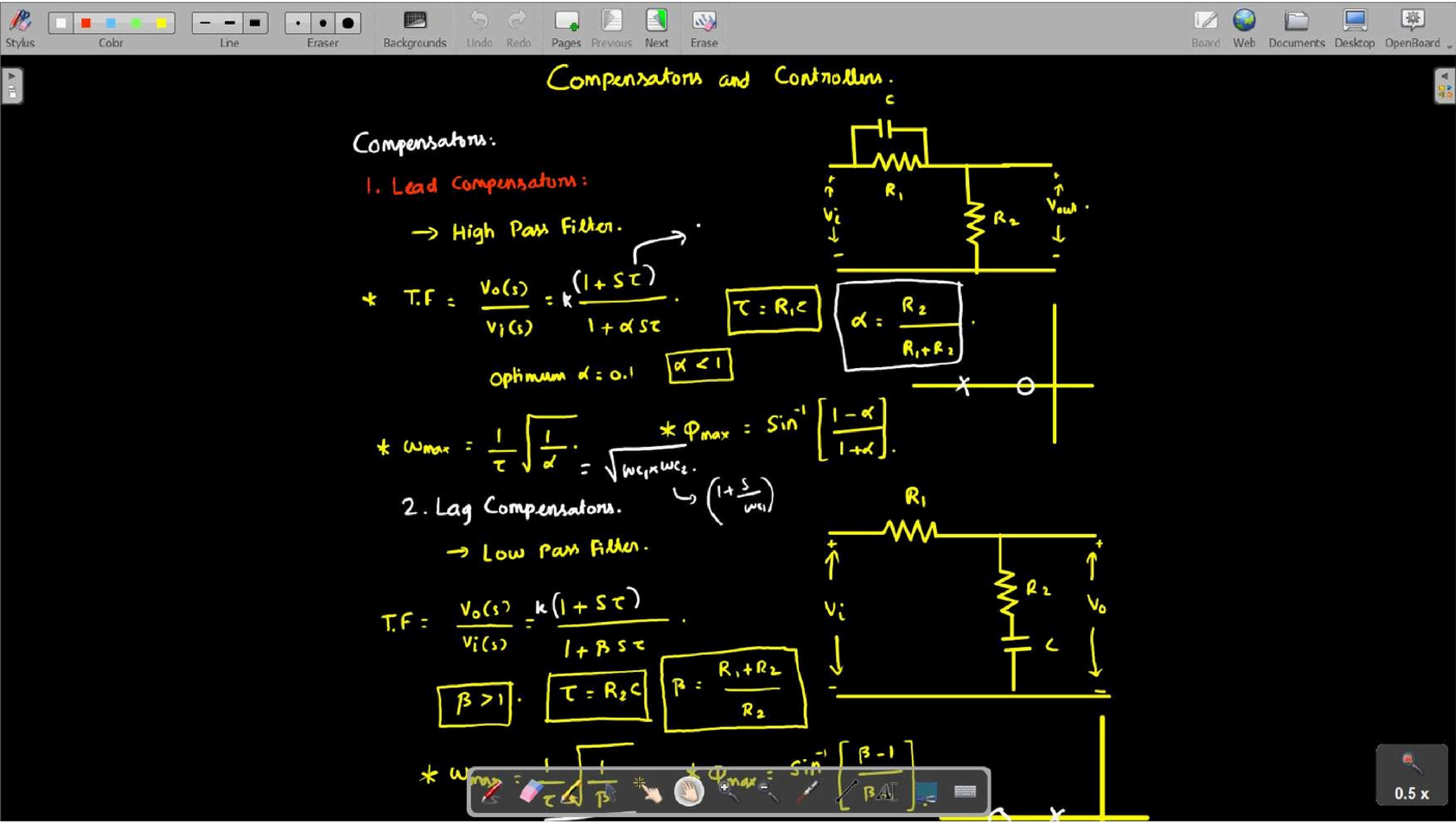
$$\hookrightarrow \left(1+\frac{s}{\omega c_1}\right)$$

$$* \quad \phi_{max} = \sin^{-1}\left[\frac{1-\alpha}{1+\alpha}\right].$$

2. Lag Compensators.

→ Low pass Filter.

Full Video Link



Compensators and Controllers.

Compensators:

1. Lead Compensators:

→ High Pass Filter.

$$* \quad T.F = \frac{V_o(s)}{V_i(s)} = k\frac{(1+S\tau)}{1+\alpha S\tau}.$$

$\boxed{\tau = R_1C}$ $\boxed{\alpha = \frac{R_2}{R_1+R_2}}$.

optimum $\alpha = 0.1$ $\boxed{\alpha < 1}$

$$* \quad \omega_{max} = \frac{1}{\tau}\sqrt{\frac{1}{\alpha}}. = \sqrt{\omega c_1 \times \omega c_2}.$$

$\hookrightarrow \left(1+\frac{S}{\omega c_1}\right)$

$$* \quad \phi_{max} = \sin^{-1}\left[\frac{1-\alpha}{1+\alpha}\right].$$

2. Lag Compensators.

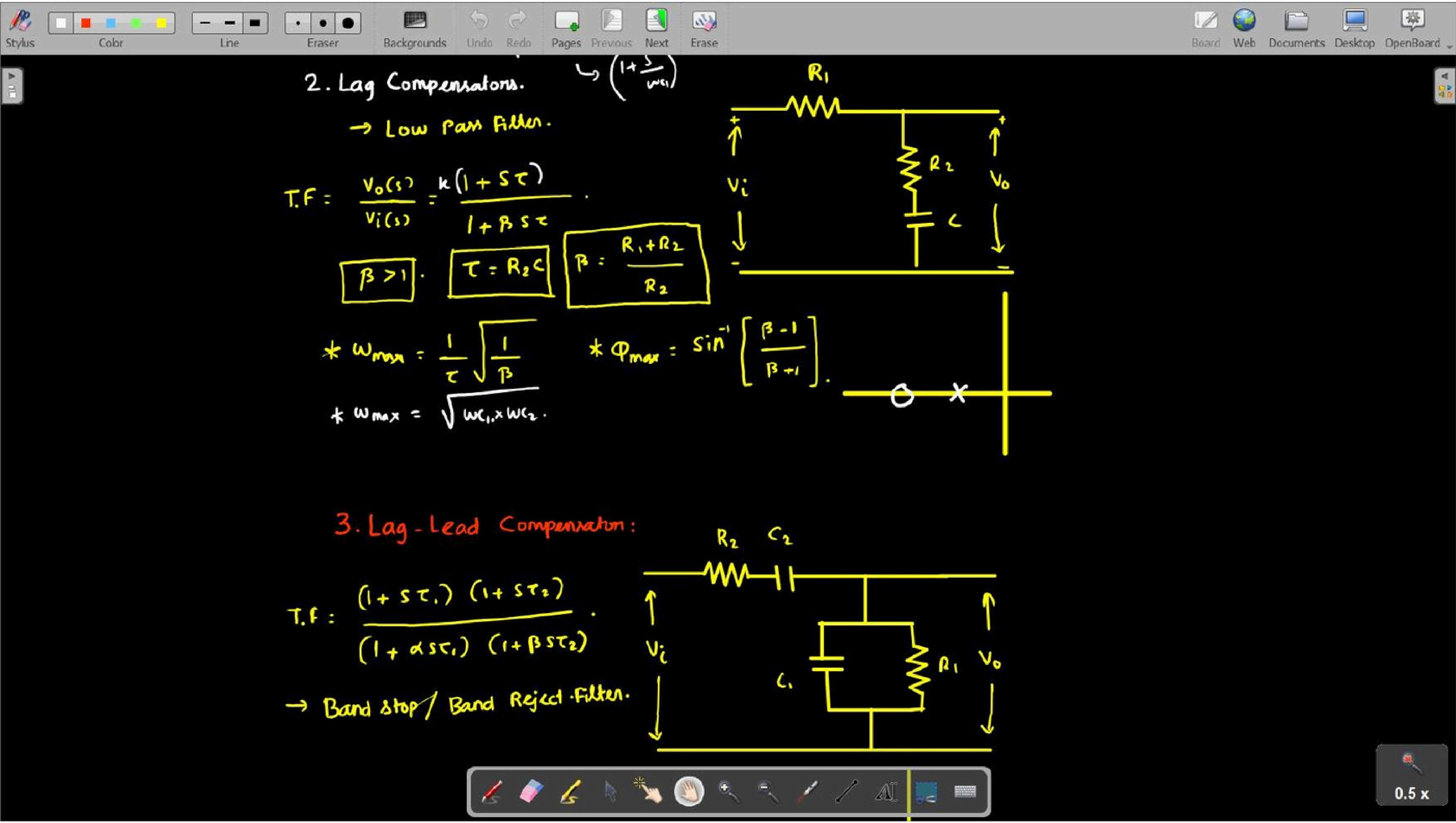
→ Low pass Filter.

$$T.F = \frac{V_o(s)}{V_i(s)} = \frac{k(1+S\tau)}{1+\beta S\tau}.$$

$\boxed{\beta > 1}$. $\boxed{\tau = R_2C}$ $\boxed{\beta = \frac{R_1+R_2}{R_2}}$

$$* \quad \omega_{max} = \frac{1}{\tau}\sqrt{\frac{1}{\beta}} \qquad * \quad \phi_{max} = \sin^{-1}\left[\frac{\beta-1}{\beta}\right].$$

Full Video Link



↳ $\left(1+\frac{s}{w_{c1}}\right)$

2. Lag Compensators.

→ Low Pass Filter.

$$T.F = \frac{V_o(s)}{V_i(s)} = \frac{k(1+s\tau)}{1+\beta s\tau}.$$

$\boxed{\beta > 1}$. $\boxed{\tau = R_2 C}$ $\boxed{\beta = \frac{R_1+R_2}{R_2}}$

* $\omega_{max} = \frac{1}{\tau}\sqrt{\frac{1}{\beta}}$ * $\phi_{max} = \sin^{-1}\left[\frac{\beta-1}{\beta+1}\right].$

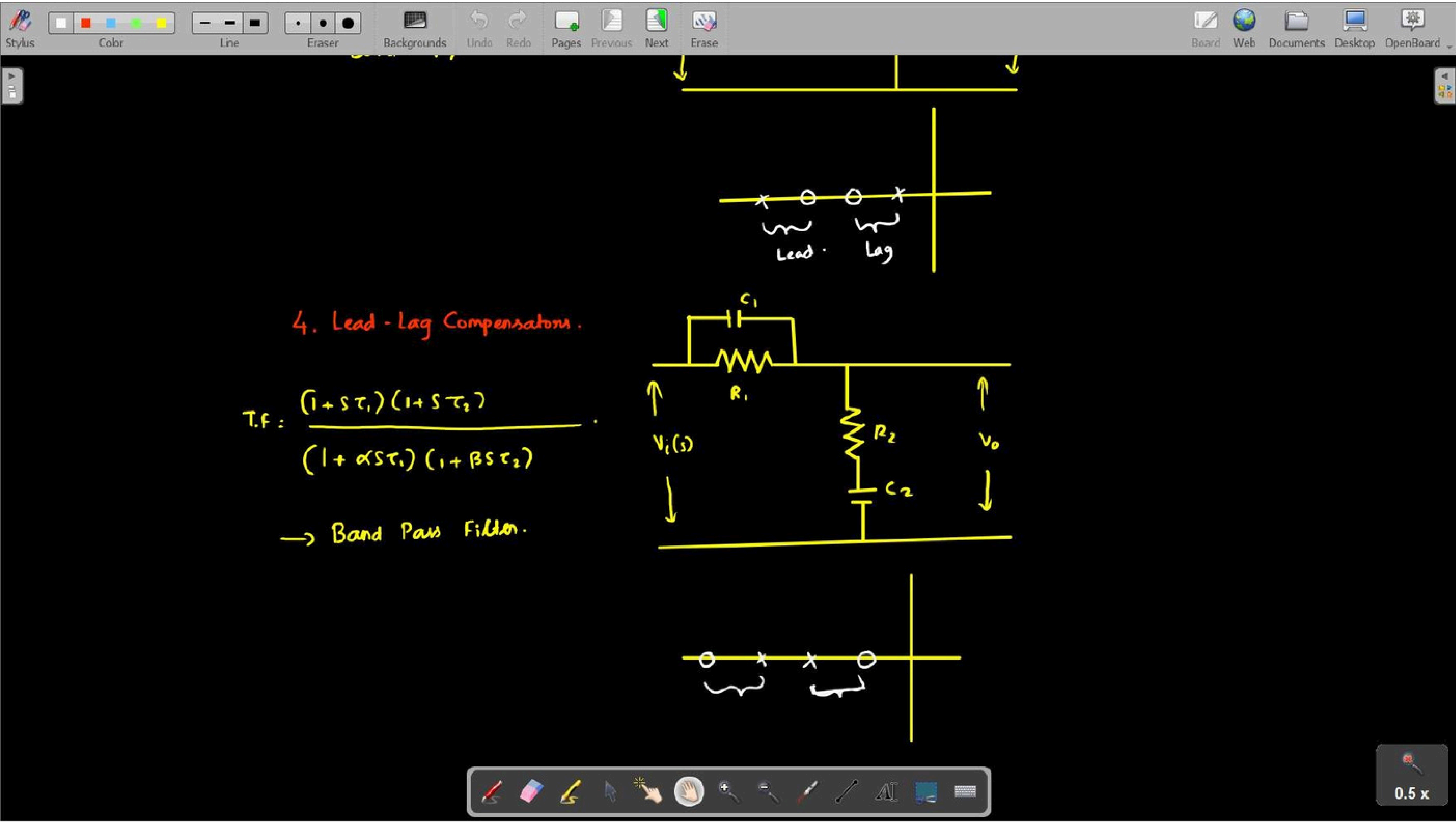
* $\omega_{max} = \sqrt{wc_1 \times wc_2}.$

3. Lag-Lead Compensator:

$$T.F : \frac{(1+s\tau_1)\,(1+s\tau_2)}{(1+\alpha s\tau_1)\,(1+\beta s\tau_2)}.$$

→ Band stop / Band Reject Filter.

Full Video Link

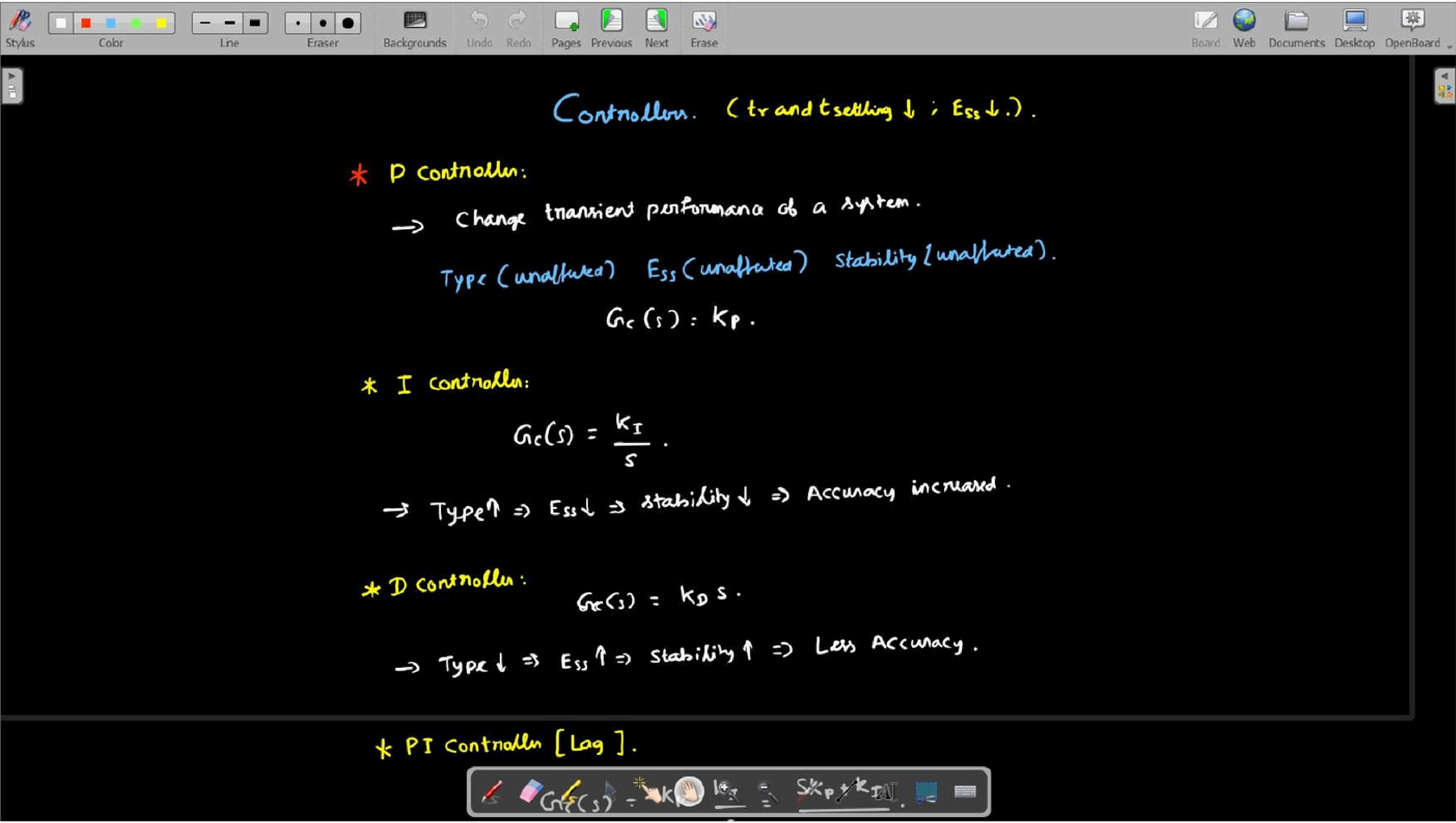


4. Lead - Lag Compensators.

$$T.F : \frac{(1+s\tau_1)(1+s\tau_2)}{(1+\alpha s\tau_1)(1+\beta s\tau_2)}.$$

→ Band Pass Filter.

Full Video Link



Controller. (tr and tsettling ↓ ; E_{ss} ↓.).

* P controller:

→ Change transient performance of a system.

Type (unaffected) E_{ss} (unaffected) Stability (unaffected).

$$G_c(s) : K_p .$$

* I controller:

$$G_c(s) = \frac{K_I}{s} .$$

→ Type↑ ⇒ E_{ss}↓ ⇒ stability↓ ⇒ Accuracy increased.

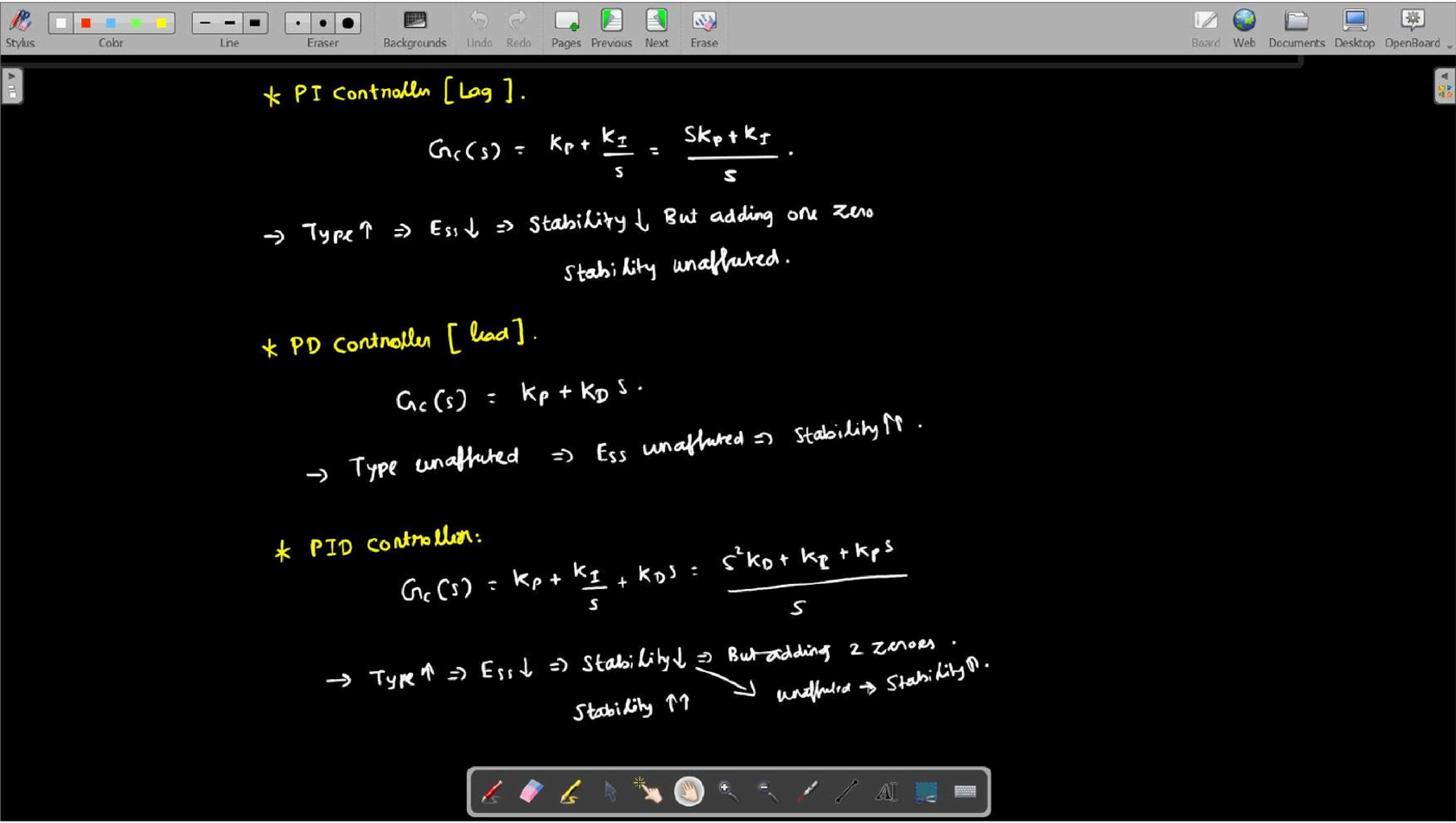
* D controller:

$$G_c(s) = K_D s .$$

→ Type↓ ⇒ E_{ss}↑ ⇒ Stability↑ ⇒ Less Accuracy.

* PI controller [Lag].

Full Video Link



* PI Controller [Lag].

$$G_c(s) = K_P + \frac{K_I}{s} = \frac{sK_P + K_I}{s}.$$

→ Type ↑ ⇒ Ess ↓ ⇒ Stability ↓ But adding one zero Stability unaffected.

* PD Controller [lead].

$$G_c(s) = K_P + K_D s.$$

→ Type unaffected ⇒ Ess unaffected ⇒ Stability ↑↑.

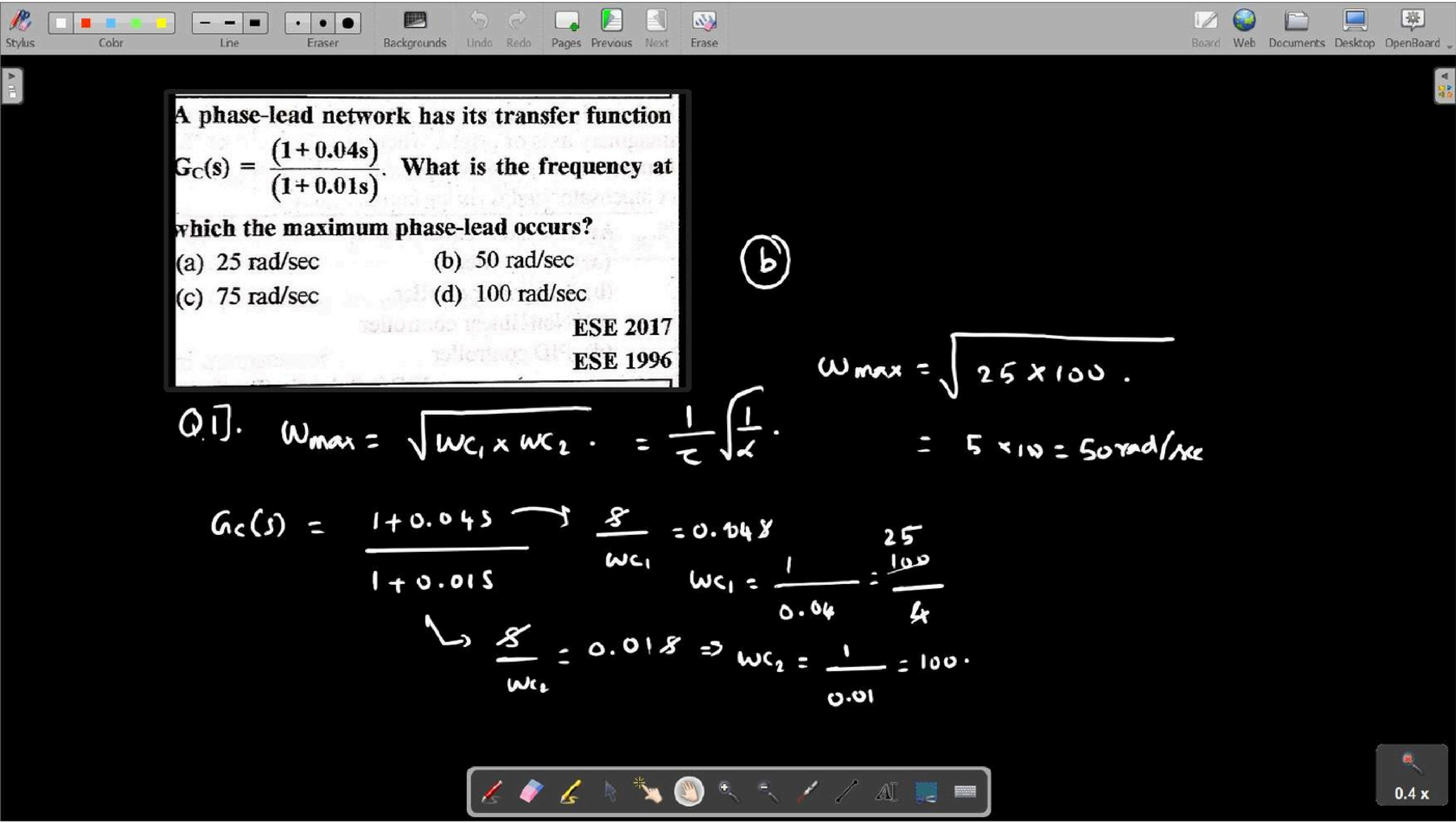
* PID controller:

$$G_c(s) = K_P + \frac{K_I}{s} + K_D s = \frac{s^2 K_D + K_I + K_P s}{s}$$

→ Type ↑ ⇒ Ess ↓ ⇒ Stability ↓ ⇒ But adding 2 zeros. → unaffected → Stability ↑↑.

Stability ↑↑

Full Video Link



A phase-lead network has its transfer function $G_C(s) = \frac{(1+0.04s)}{(1+0.01s)}$. What is the frequency at which the maximum phase-lead occurs?

(a) 25 rad/sec (b) 50 rad/sec

(c) 75 rad/sec (d) 100 rad/sec

ESE 2017

ESE 1996

ⓑ

Q1]. $\omega_{max} = \sqrt{\omega c_1 \times \omega c_2} = \frac{1}{\tau}\sqrt{\frac{1}{\alpha}}$.

$G_c(s) = \frac{1+0.04s}{1+0.01s}$

$\rightarrow \frac{s}{\omega c_1} = 0.04s$

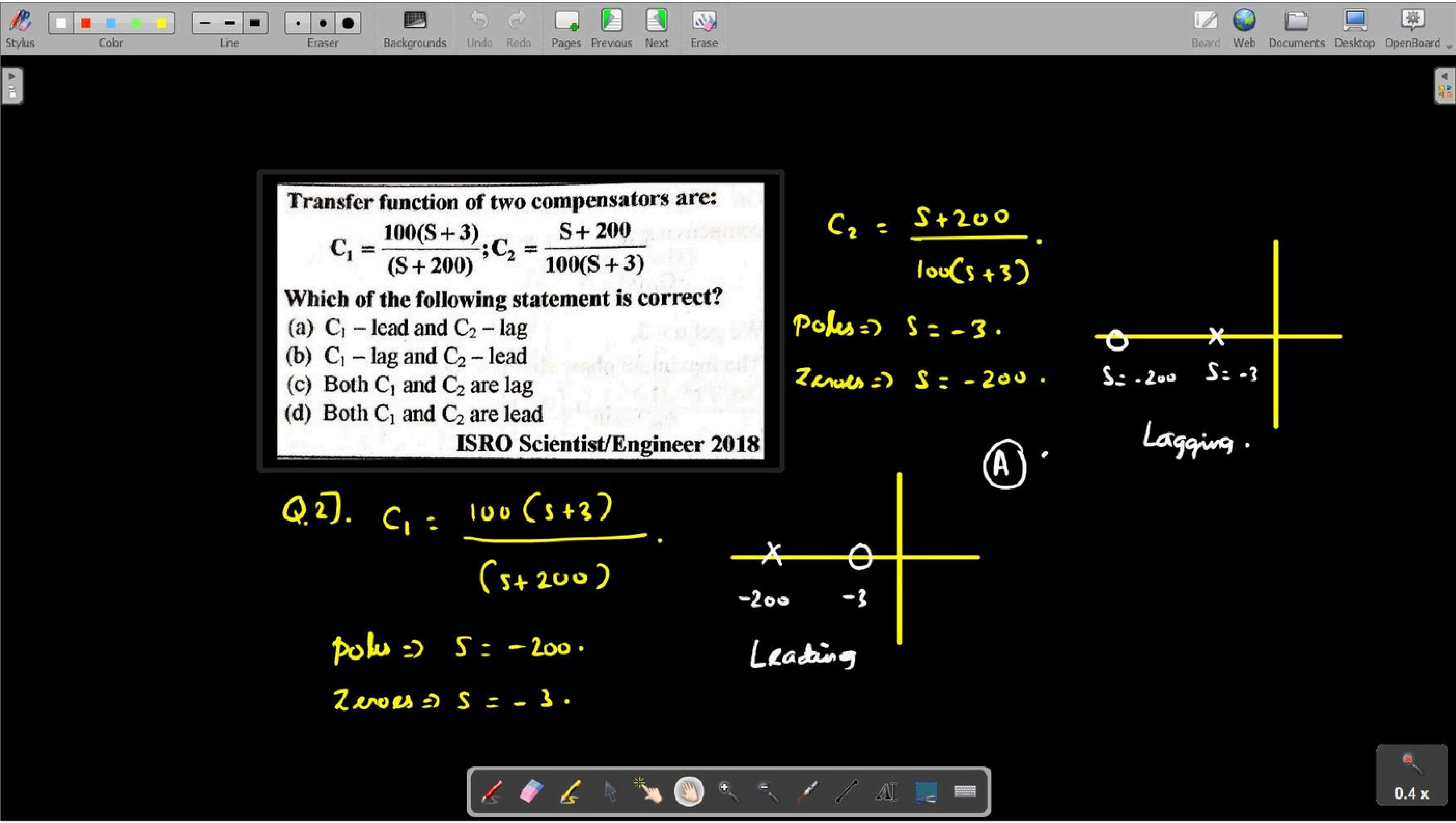
$\omega c_1 = \frac{1}{0.04} = \frac{\overset{25}{100}}{4}$

$\hookrightarrow \frac{s}{\omega c_2} = 0.01s \Rightarrow \omega c_2 = \frac{1}{0.01} = 100.$

$\omega_{max} = \sqrt{25 \times 100}.$

$= 5 \times 10 = 50$ rad/sec

Full Video Link



Transfer function of two compensators are:

$$C_1 = \frac{100(S+3)}{(S+200)}; C_2 = \frac{S+200}{100(S+3)}$$

Which of the following statement is correct?

(a) C_1 – lead and C_2 – lag

(b) C_1 – lag and C_2 – lead

(c) Both C_1 and C_2 are lag

(d) Both C_1 and C_2 are lead

ISRO Scientist/Engineer 2018

Q.2]. $C_1 = \frac{100(s+3)}{(s+200)}$.

poles ⇒ $S = -200$.

Zeroes ⇒ $S = -3$.

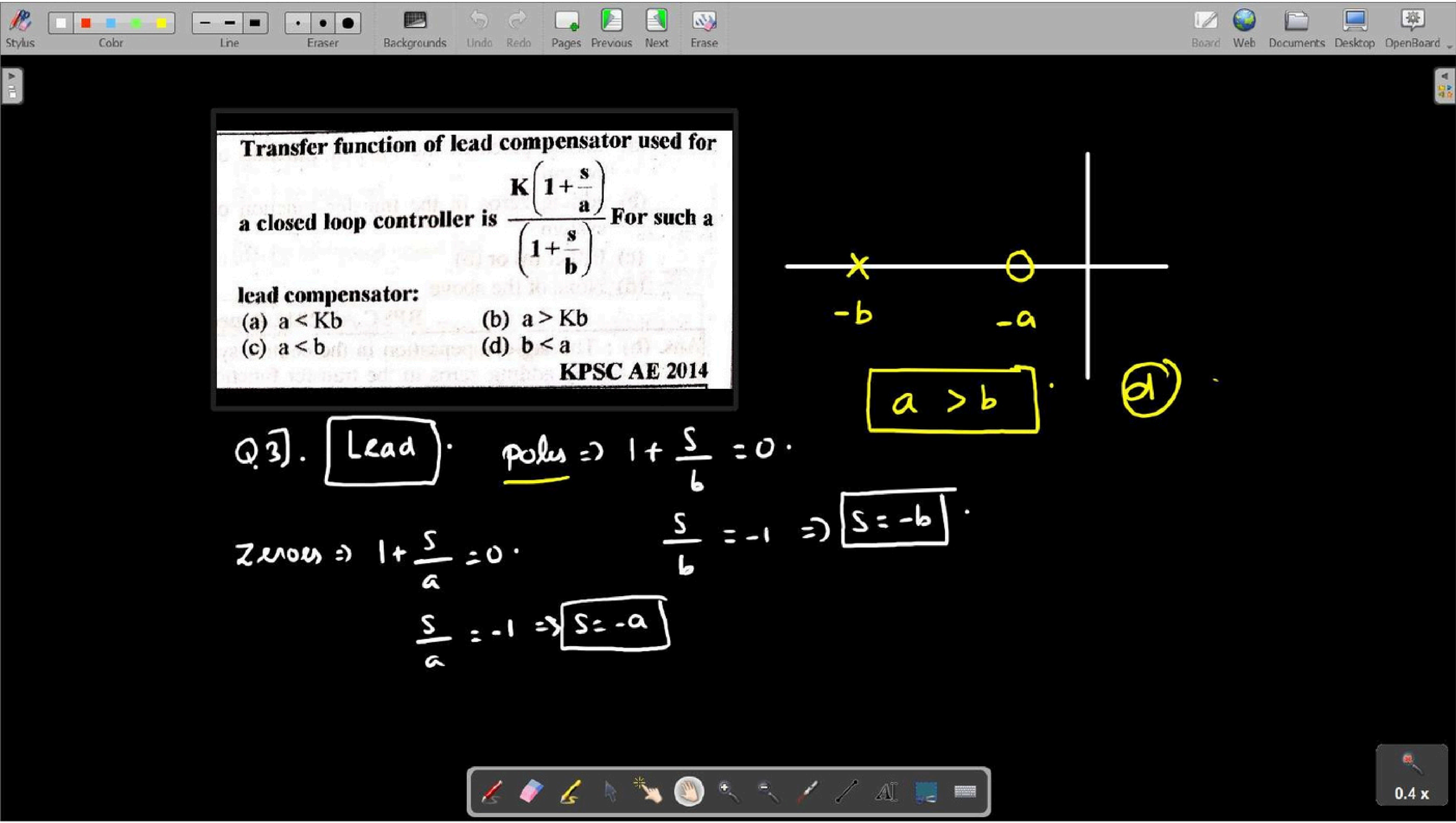
$C_2 = \frac{S+200}{100(s+3)}$.

Poles ⇒ $S = -3$.

Zeroes ⇒ $S = -200$.

Ⓐ.

Full Video Link



Transfer function of lead compensator used for a closed loop controller is $\dfrac{K\left(1+\frac{s}{a}\right)}{\left(1+\frac{s}{b}\right)}$ For such a lead compensator:

(a) $a < Kb$ (b) $a > Kb$

(c) $a < b$ (d) $b < a$

KPSC AE 2014

Q.3]. $\boxed{\text{Lead}}$.

Poles $\Rightarrow 1 + \frac{s}{b} = 0.$

$\frac{s}{b} = -1 \Rightarrow \boxed{s = -b}.$

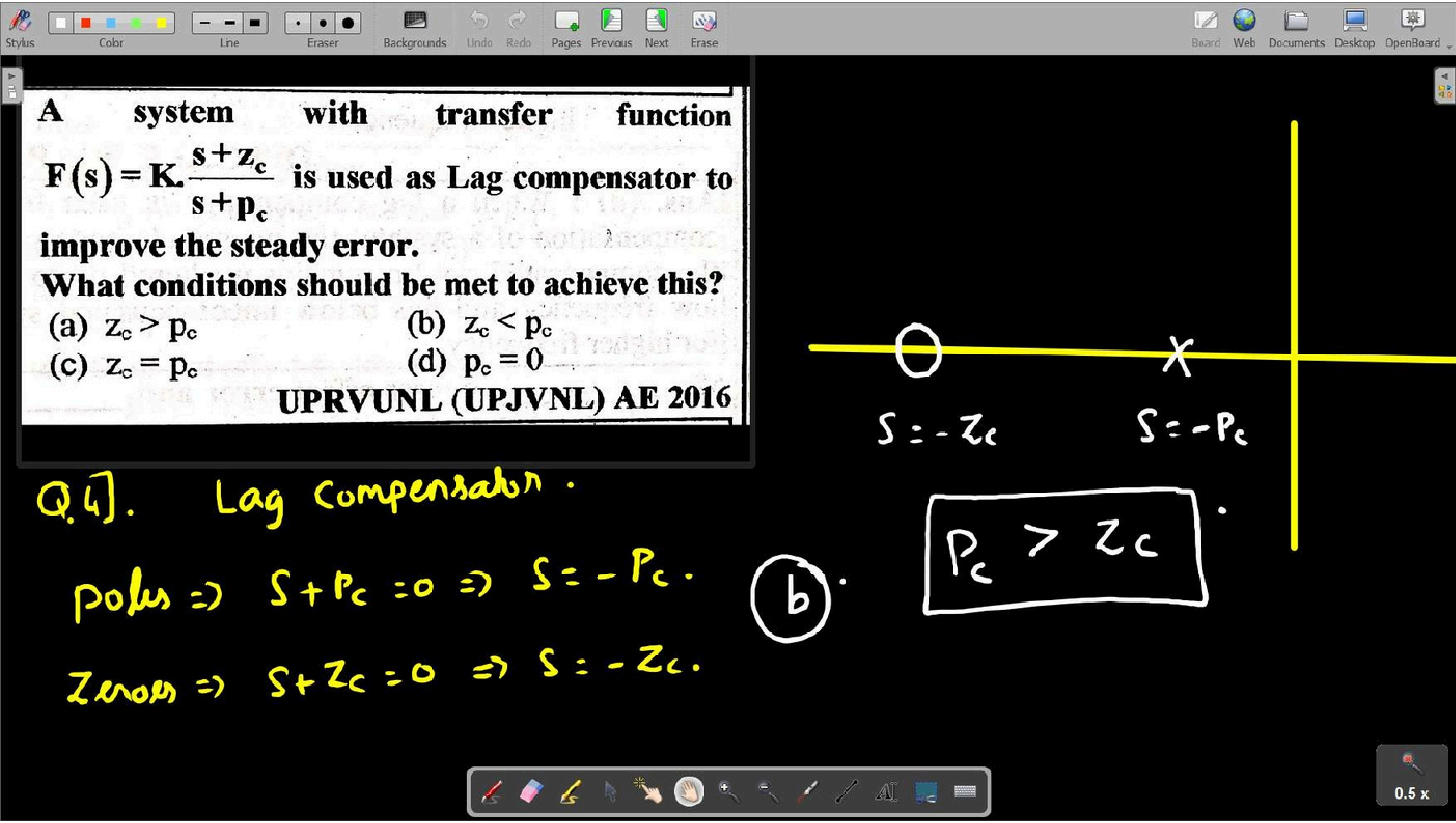
Zeroes $\Rightarrow 1 + \frac{s}{a} = 0.$

$\frac{s}{a} = -1 \Rightarrow \boxed{s = -a}$

$\boxed{a > b}.$

(d)

Full Video Link



A system with transfer function $F(s) = K.\frac{s+z_c}{s+p_c}$ is used as Lag compensator to improve the steady error.

What conditions should be met to achieve this?

(a) $z_c > p_c$
(b) $z_c < p_c$
(c) $z_c = p_c$
(d) $p_c = 0$

UPRVUNL (UPJVNL) AE 2016

Q.4]. Lag compensator.

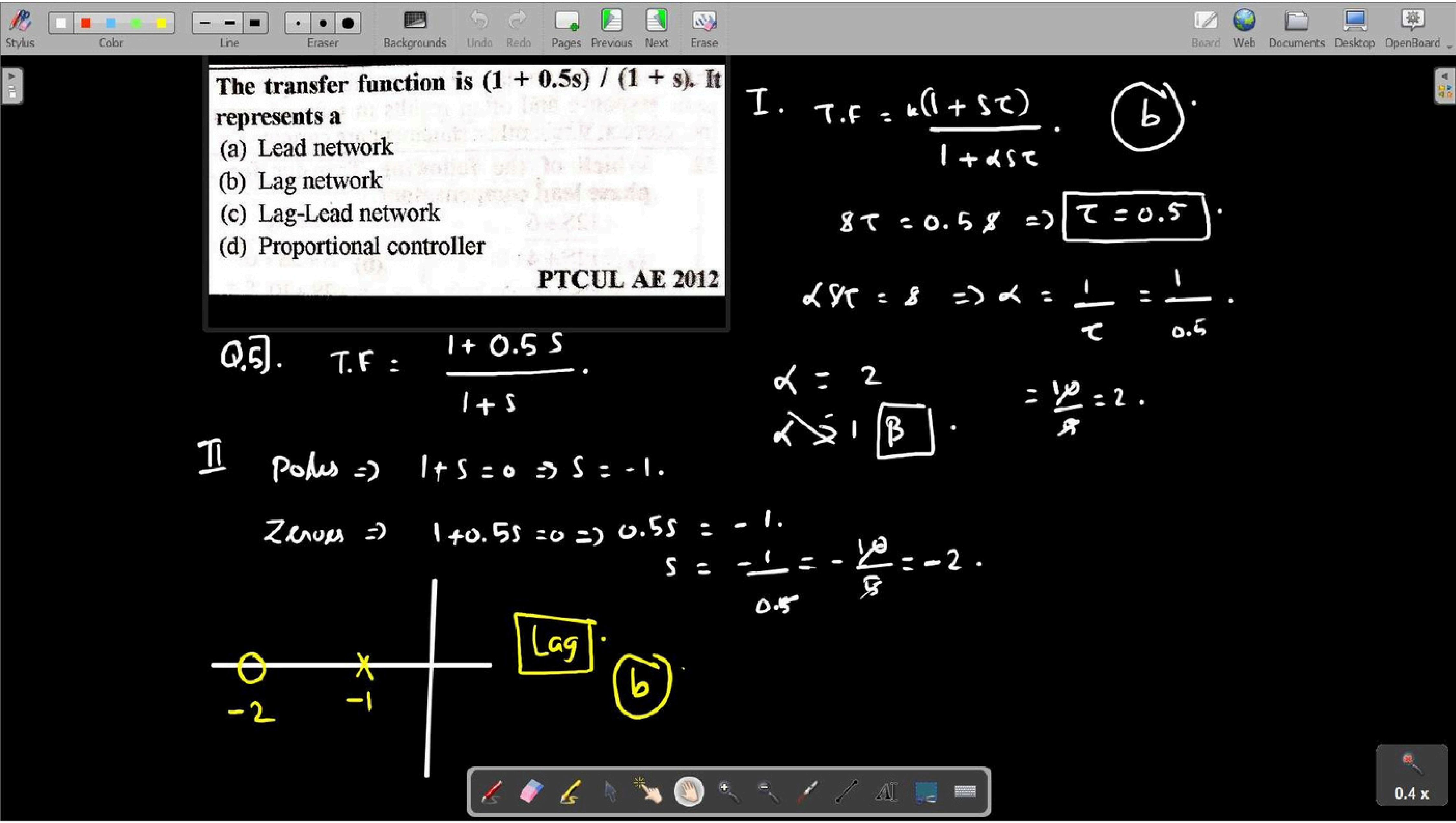
poles ⇒ $S + P_c = 0 \Rightarrow S = -P_c$.

Zeros ⇒ $S + Z_c = 0 \Rightarrow S = -Z_c$.

Ⓑ.

$\boxed{P_c > Z_c}$.

Full Video Link



The transfer function is (1 + 0.5s) / (1 + s). It represents a

(a) Lead network
(b) Lag network
(c) Lag-Lead network
(d) Proportional controller

PTCUL AE 2012

Q.5]. $T.F = \frac{1+0.5S}{1+s}$.

I. $T.F = \frac{k(1+s\tau)}{1+\alpha s\tau}$. $\boxed{b}$.

$\cancel{s}\tau = 0.5\cancel{s} \Rightarrow \boxed{\tau = 0.5}$.

$\alpha \cancel{s}\tau = \cancel{s} \Rightarrow \alpha = \frac{1}{\tau} = \frac{1}{0.5}$.

$= \frac{1\cancel{0}}{\cancel{5}} = 2$.

$\alpha = 2$

$\alpha > 1$ $\boxed{B}$.

II Poles $\Rightarrow 1+s=0 \Rightarrow s=-1$.

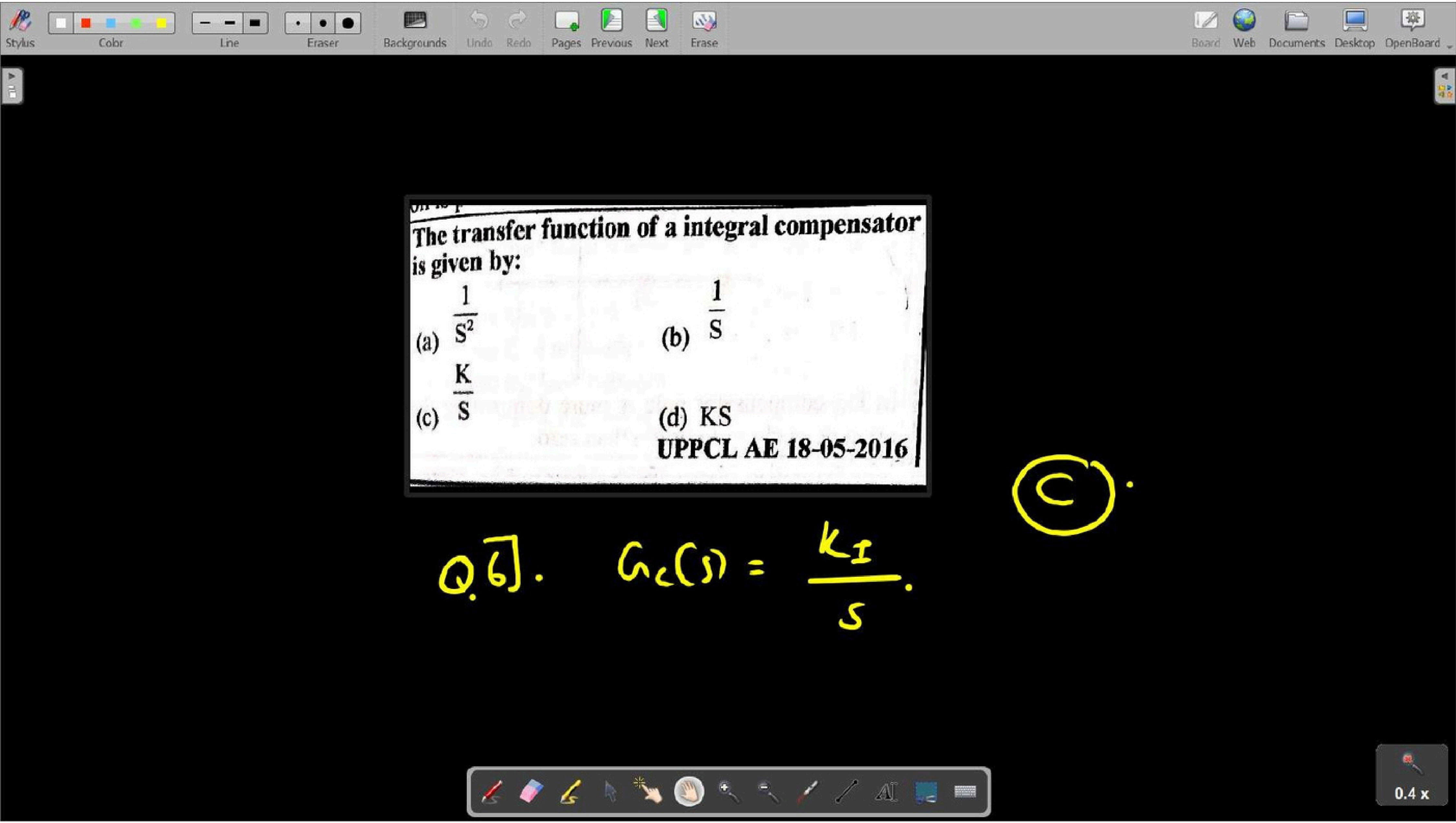
Zeros $\Rightarrow 1+0.5s=0 \Rightarrow 0.5s=-1$.

$s = \frac{-1}{0.5} = -\frac{1\cancel{0}}{\cancel{5}} = -2$.

$\boxed{\text{Lag}}$.

$\boxed{b}$.

Full Video Link



The transfer function of a integral compensator is given by:

(a) $\frac{1}{S^2}$

(b) $\frac{1}{S}$

(c) $\frac{K}{S}$

(d) KS

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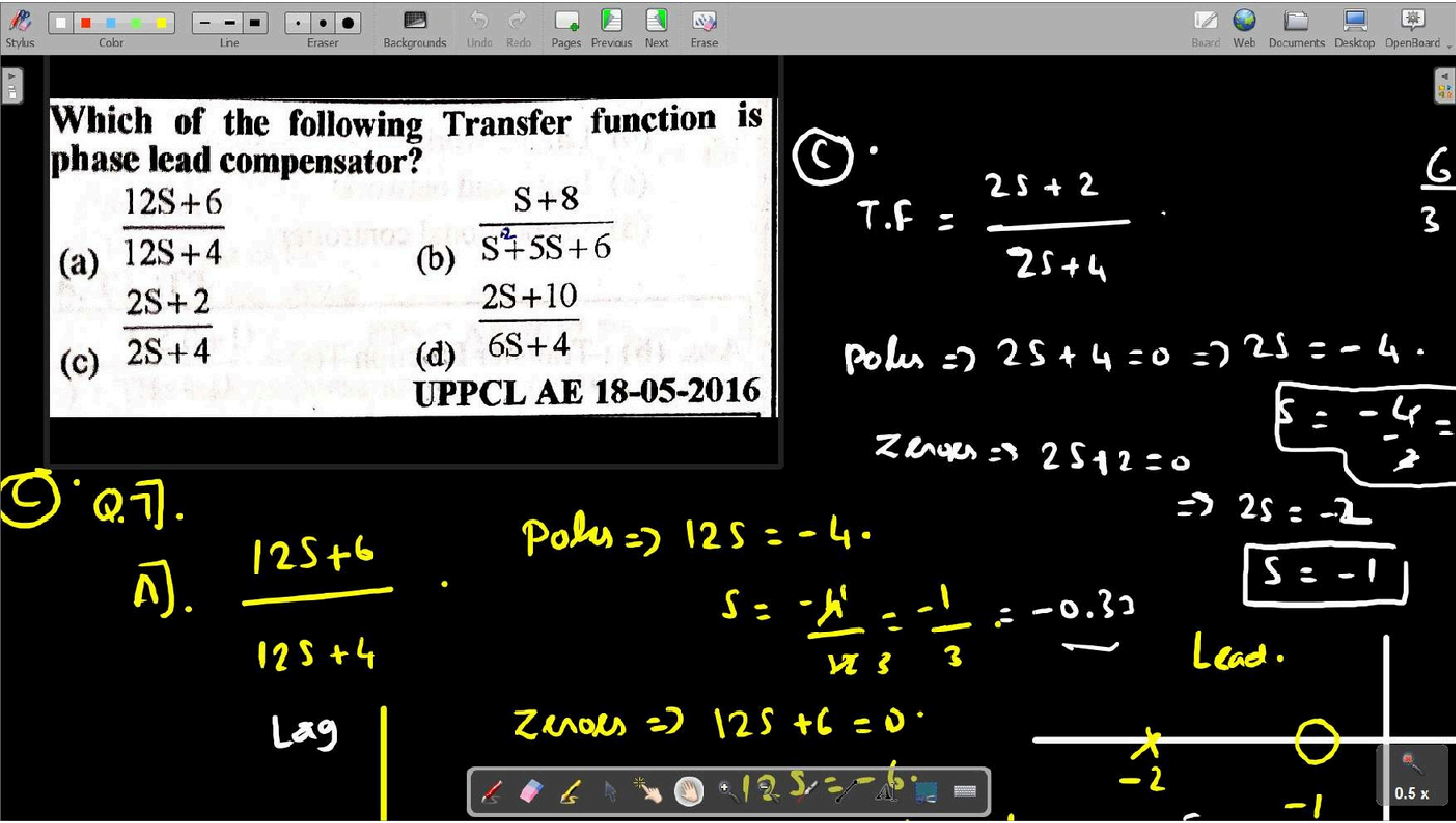
ⓒ.

Q.6]. $G_c(s) = \frac{K_I}{s}$.



Which of the following Transfer function is phase lead compensator?

(a) $\frac{12S+6}{12S+4}$ (b) $\frac{S+8}{S^2+5S+6}$

(c) $\frac{2S+2}{2S+4}$ (d) $\frac{2S+10}{6S+4}$

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S. Q.7.

A). $\frac{12s+6}{12s+4}$.

Lag

Poles $\Rightarrow 12s = -4.$

$s = \frac{-\cancel{4}}{\cancel{12}\,3} = \frac{-1}{3} = -0.33$

Zeros $\Rightarrow 12s+6 = 0.$

$12s = -6.$

C. T.F $= \frac{2s+2}{2s+4}$.

Poles $\Rightarrow 2s+4 = 0 \Rightarrow 2s = -4.$

$\boxed{s = \frac{-4}{2} =}$

Zeros $\Rightarrow 2s+2 = 0$

$\Rightarrow 2s = -2$

$\boxed{s = -1}$

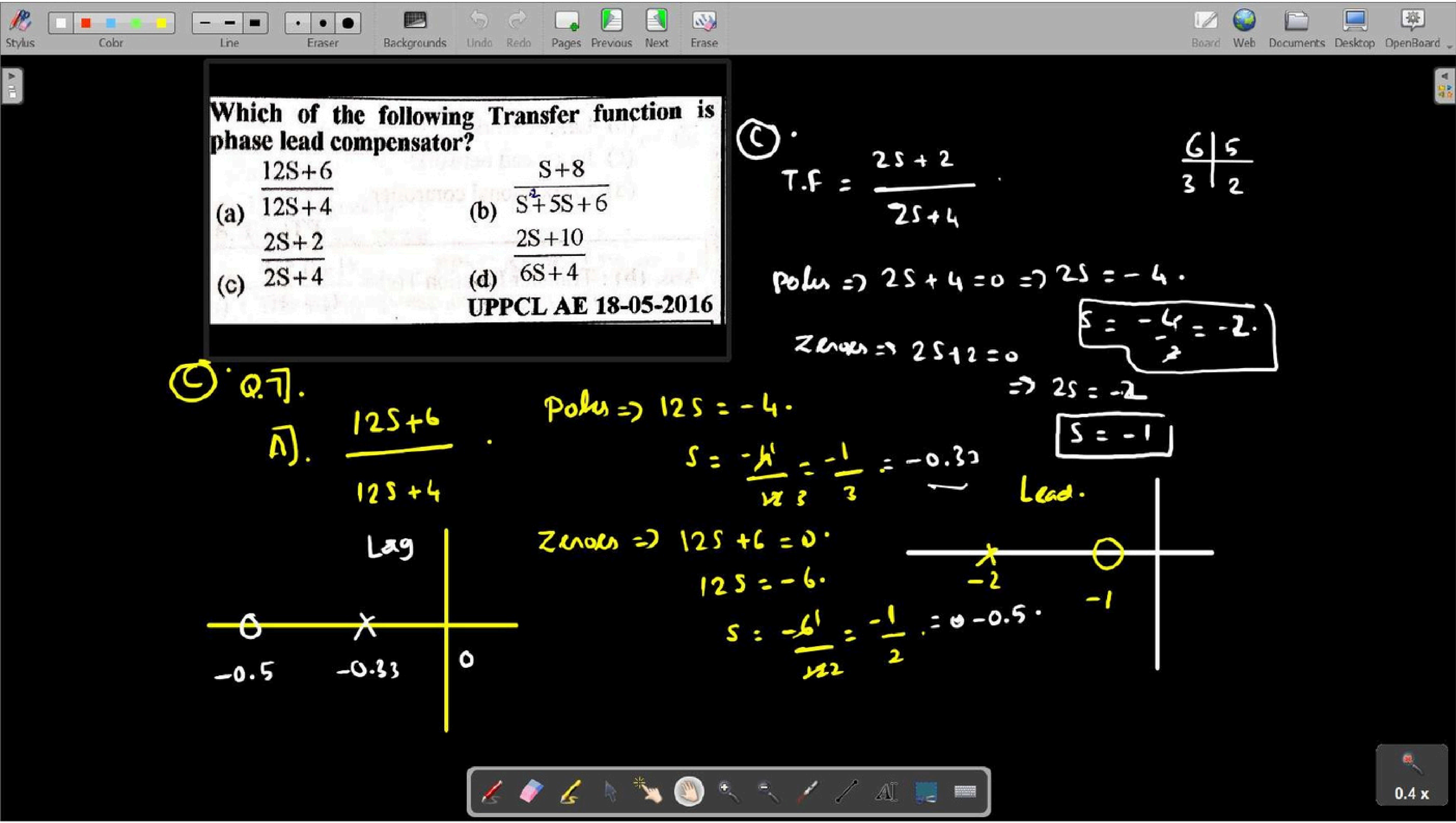
Lead.

-2

-1

$\frac{6}{3}$

Full Video Link



Which of the following Transfer function is phase lead compensator?

(a) $\frac{12S+6}{12S+4}$ (b) $\frac{S+8}{S^2+5S+6}$

(c) $\frac{2S+2}{2S+4}$ (d) $\frac{2S+10}{6S+4}$

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Ⓒ.

$T.F = \frac{2S+2}{2S+4}.$

$\frac{6}{3} \Big| \frac{5}{2}$

Poles $\Rightarrow 2S+4=0 \Rightarrow 2S=-4.$

$\boxed{S = -\frac{4}{\cancel{2}} = -2.}$

Zeroes $\Rightarrow 2S+2=0$

$\Rightarrow 2S = -2$

$\boxed{S=-1}$

Lead.

−2 −1

Ⓒ. Q.7.

A). $\frac{12S+6}{12S+4}.$

Poles $\Rightarrow 12S=-4.$

$S = \frac{-\cancel{4}}{\cancel{12}\,3} = \frac{-1}{3} = -0.33$

Zeroes $\Rightarrow 12S+6=0.$

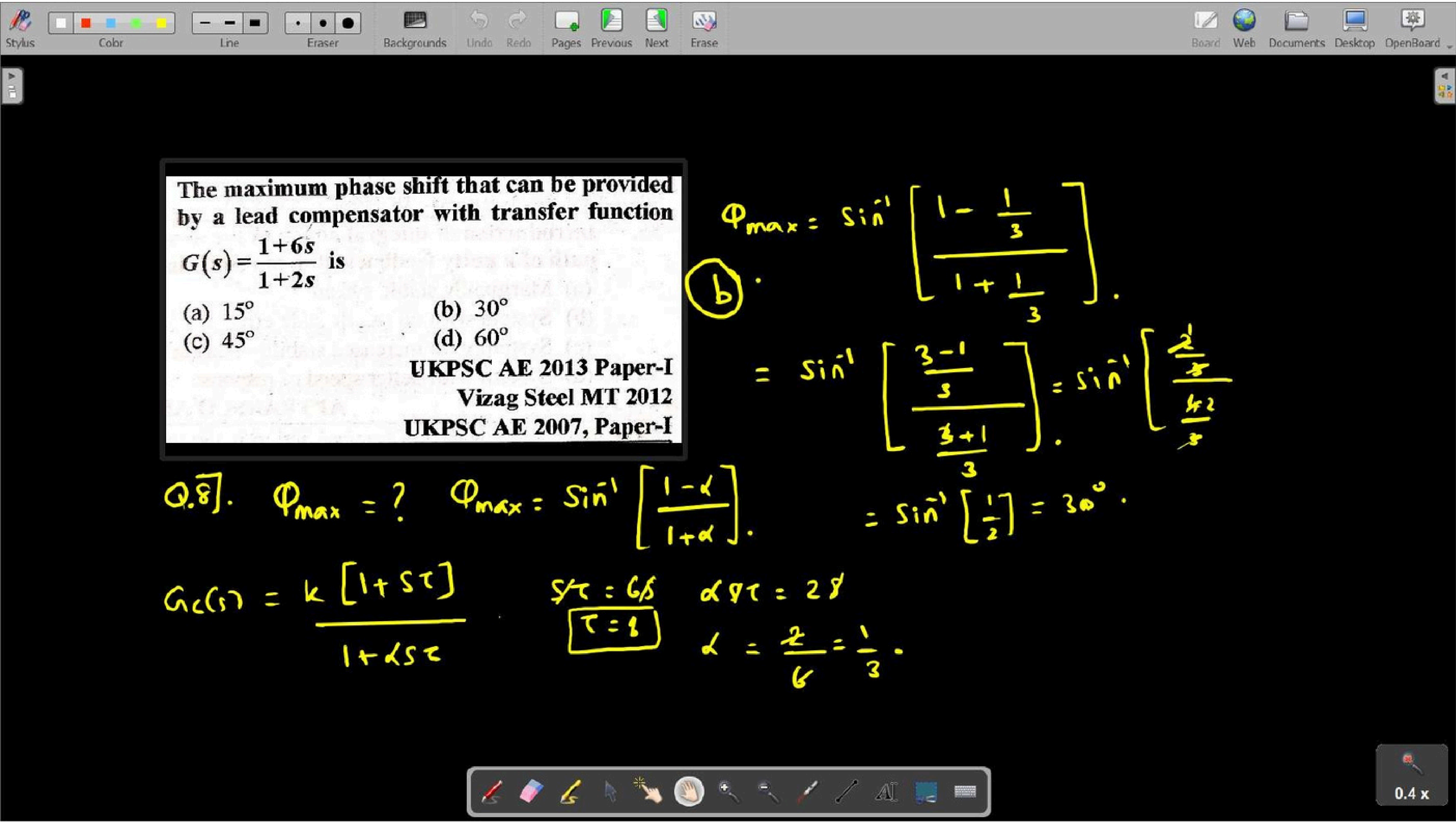
$12S=-6.$

$S = \frac{-\cancel{6}}{\cancel{12}\,2} = \frac{-1}{2} = -0.5.$

Lag

−0.5 −0.33 0

Full Video Link



The maximum phase shift that can be provided by a lead compensator with transfer function $G(s)=\frac{1+6s}{1+2s}$ is

(a) 15°
(b) 30°
(c) 45°
(d) 60°

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UKPSC AE 2007, Paper-I

Q.8]. $\phi_{max} = ?$ $\quad \phi_{max} = \sin^{-1}\left[\frac{1-\alpha}{1+\alpha}\right].$

$$G_c(s) = \frac{k[1+s\tau]}{1+\alpha s\tau}$$

$\cancel{s}\tau = 6\cancel{s}$ $\quad \alpha \cancel{s}\tau = 2\cancel{s}$

$\boxed{\tau = 6}$ $\quad \alpha = \frac{2}{6} = \frac{1}{3}.$

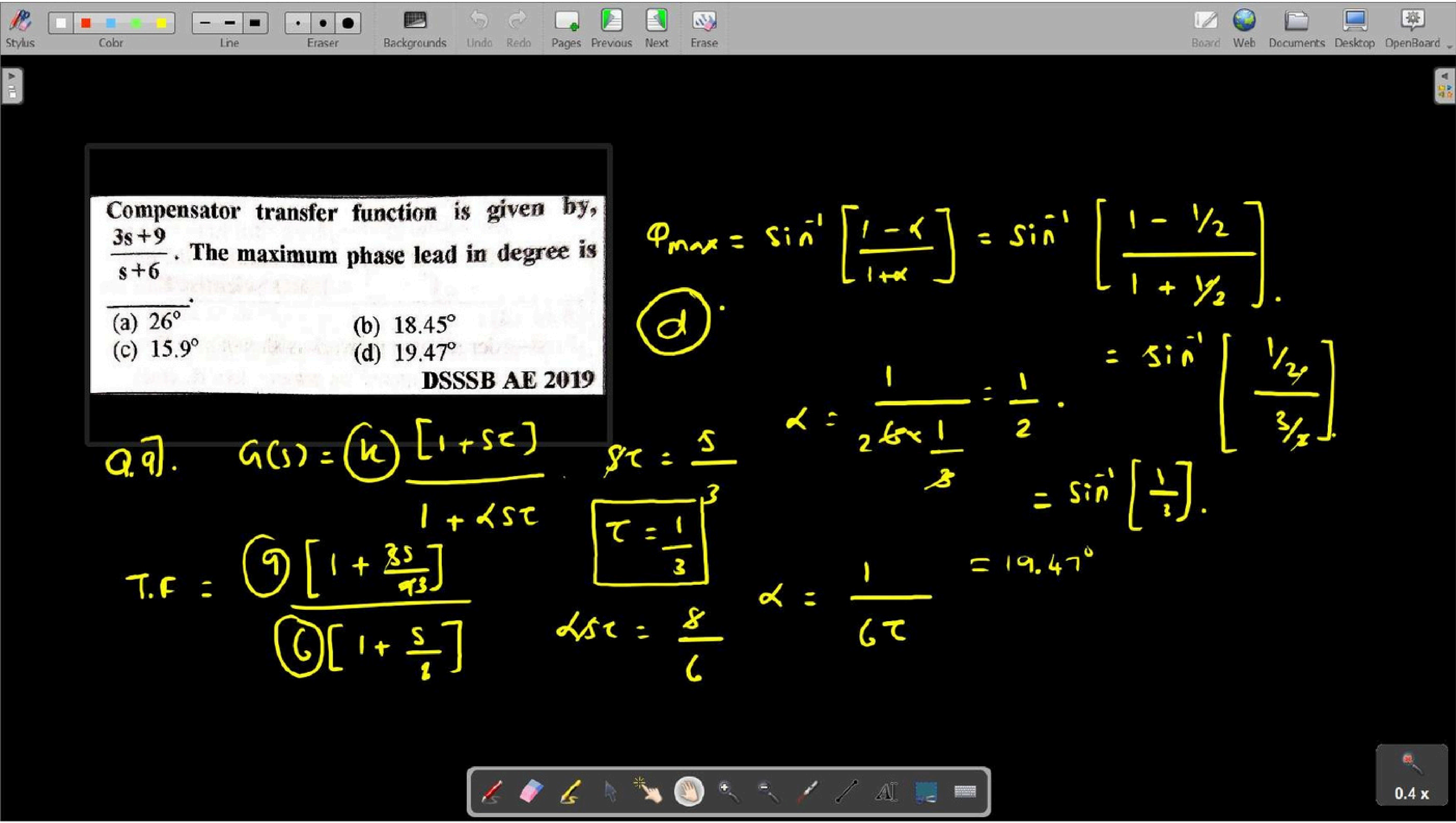
$$\phi_{max} = \sin^{-1}\left[\frac{1-\frac{1}{3}}{1+\frac{1}{3}}\right].$$

ⓑ.

$$= \sin^{-1}\left[\frac{\frac{3-1}{3}}{\frac{3+1}{3}}\right]. = \sin^{-1}\left[\frac{\frac{\cancel{2}^{1}}{\cancel{3}}}{\frac{\cancel{4}^{2}}{\cancel{3}}}\right]$$

$$= \sin^{-1}\left[\frac{1}{2}\right] = 30^{\circ}.$$

Full Video Link



Compensator transfer function is given by, $\frac{3s+9}{s+6}$. The maximum phase lead in degree is ______.

(a) 26° (b) 18.45°

(c) 15.9° (d) 19.47°

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Q.9].

$$G(s) = \textcircled{k}\,\frac{[1+s\tau]}{1+\alpha s\tau}$$

$$T.F = \frac{\textcircled{9}\left[1+\frac{3s}{\cancel{9}\,3}\right]}{\textcircled{6}\left[1+\frac{s}{6}\right]}$$

$$s\tau = \frac{s}{3}$$

$$\boxed{\tau = \frac{1}{3}}$$

$$\alpha s\tau = \frac{s}{6}$$

$$\alpha = \frac{1}{6\tau}$$

$$\alpha = \frac{1}{2\cancel{6}\times\frac{1}{\cancel{3}}} = \frac{1}{2}.$$

$$\phi_{max} = \sin^{-1}\left[\frac{1-\alpha}{1+\alpha}\right] = \sin^{-1}\left[\frac{1-1/2}{1+1/2}\right].$$

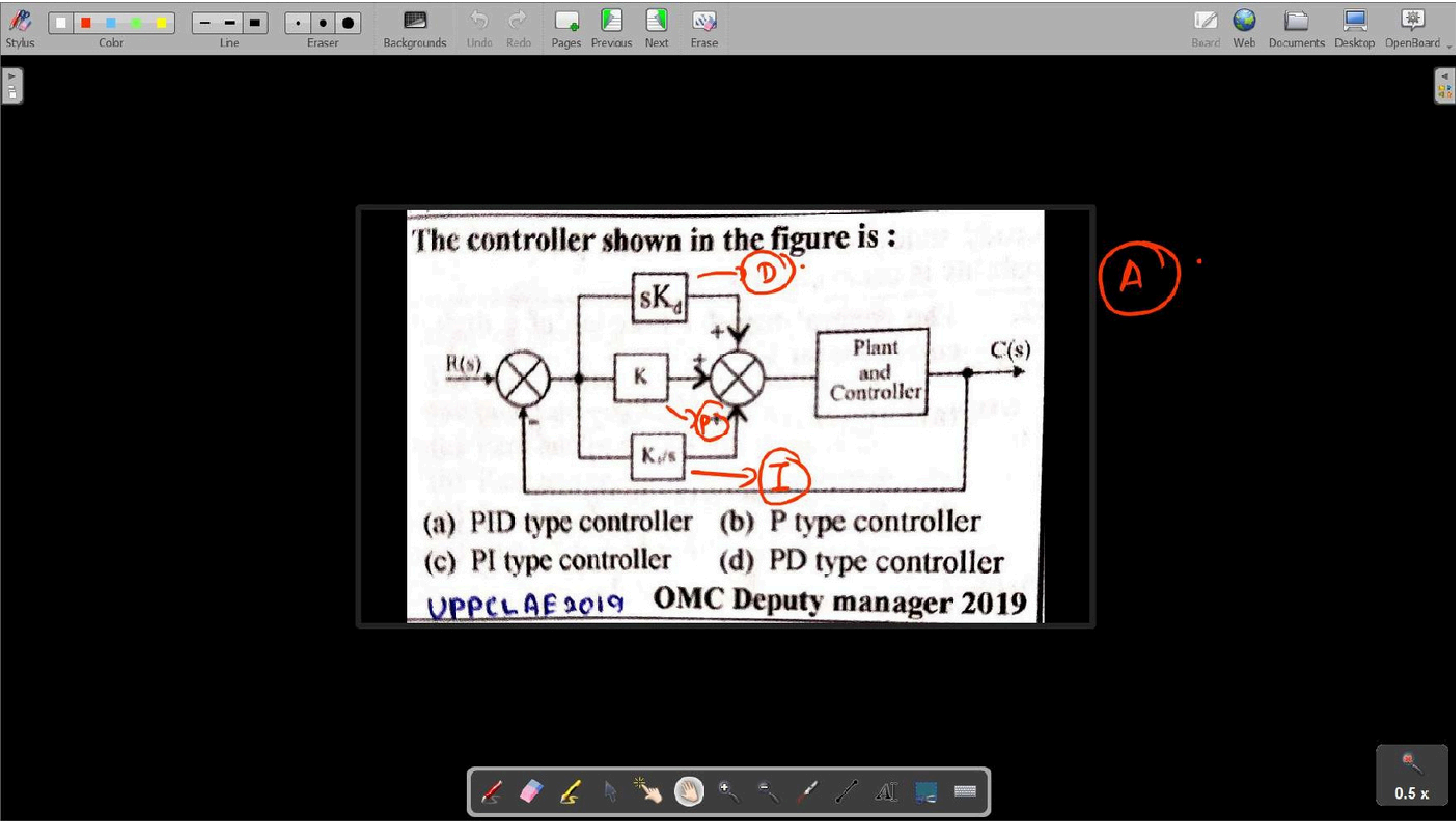
$$= \sin^{-1}\left[\frac{1/\cancel{2}}{3/\cancel{2}}\right]$$

$$= \sin^{-1}\left[\frac{1}{3}\right].$$

$$= 19.47^{\circ}$$

ⓓ.

Full Video Link



The controller shown in the figure is :

(a) PID type controller (b) P type controller

(c) PI type controller (d) PD type controller

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