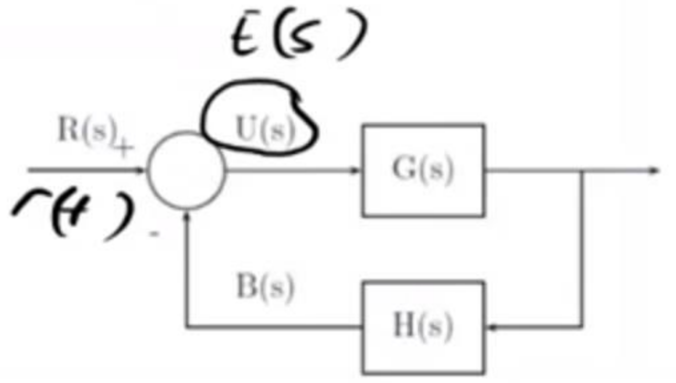
# EE 250: Control Systems Analysis
# Module II: Block Diagram & SFG
# Lecture 10: Block Diagram


Dr Laxmidhar Behera

Professor, Department of EE, IIT Kanpur




$Y(s) \leftrightarrow y(t)$

$y(t)$ should follow $r(t)$

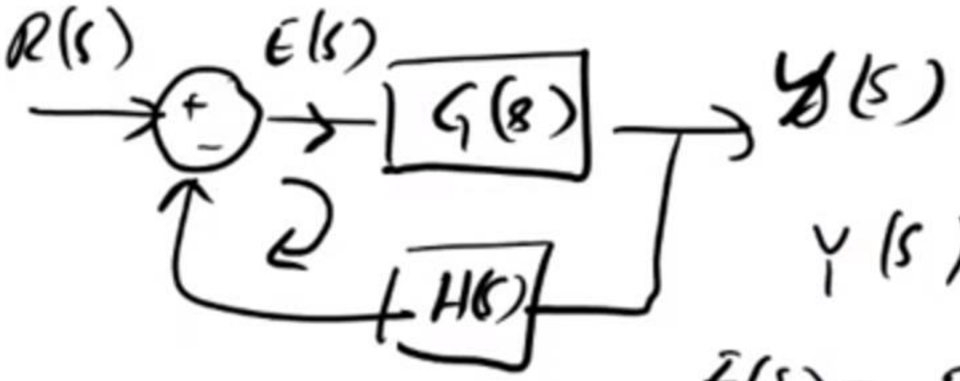
$R(s) \leftrightarrow r(t) \rightarrow$ Command or reference signal

$E(s) \leftrightarrow e(t) = r(t) - y(t) \leftarrow$ error correction loop

$E(s) = R(s) - Y(s)$

$G(s) \rightarrow$ ~~Forward gain~~ $\rightarrow$ TF of the forward path

$H(s) \rightarrow$ TF of the feedback path




$$Y(s) = G(s)E(s)$$

$$E(s) = R(s) - H(s)Y(s)$$

$$Y(s) = G(s)\left[R(s) - H(s)Y(s)\right]$$

$$= G(s)R(s) - G(s)H(s)Y(s)$$

$$Y(s)\left[1 + G(s)H(s)\right] = G(s)R(s), \quad TF = T(s) = \frac{Y(s)}{R(s)}$$

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

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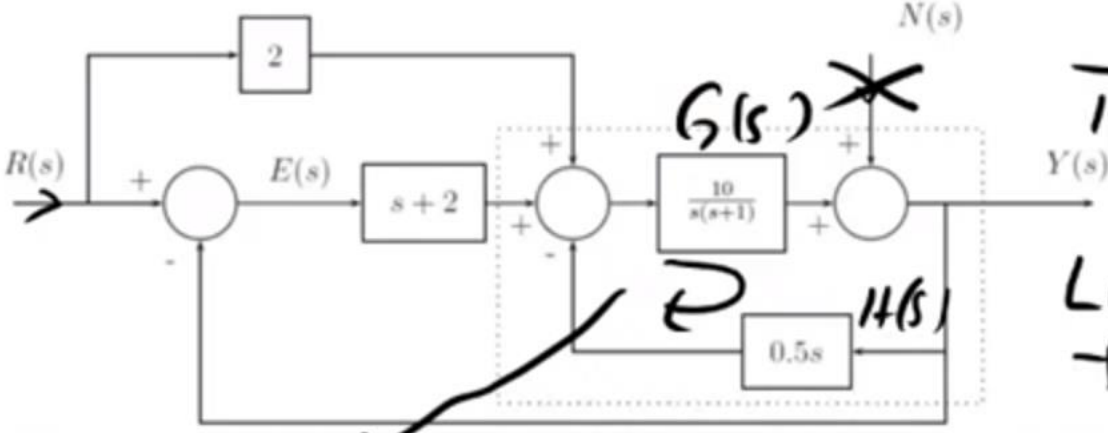
# Simplify this Block diagram & find




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

Linear System → Superposition

Find $\dfrac{10/s(s+1)}{1+\left(\dfrac{10}{s(s+1)}\right)0.5(s)} = \dfrac{10}{s(s+6)}$

$R(s) \to Y_1(s)$

$N(s) \to Y_2(s)$

$\alpha R(s) + \beta N(s) \Rightarrow \alpha Y_1(s) + \beta Y_2(s)$

(a) $\left.\frac{Y(s)}{R(s)}\right|_{N=0}$ (b) $\left.\frac{Y(s)}{E(s)}\right|_{N=0}$ (c) $\left.\frac{Y(s)}{N(s)}\right|_{R=0}$

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Step 1 $\quad N(s) = 0$

Step (2)

$$\frac{\dfrac{10}{s(s+1)}}{1+\dfrac{10}{s(s+1)}\times 0.5s} = \frac{10}{s(s+6)}$$

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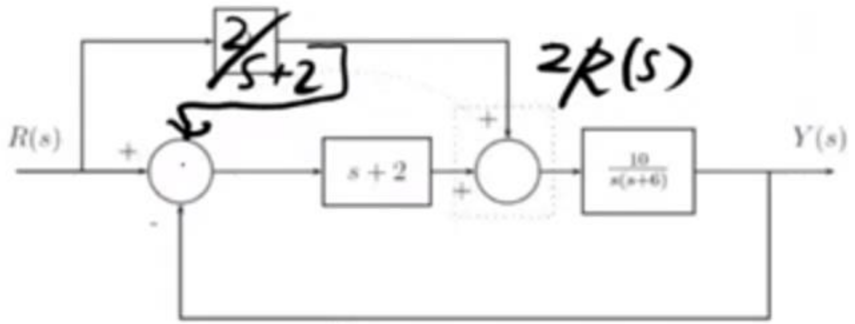
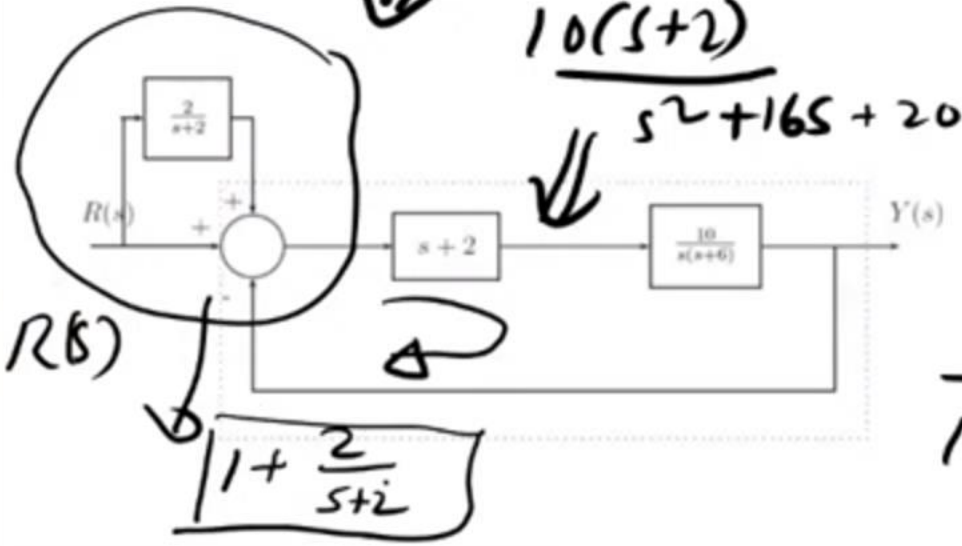


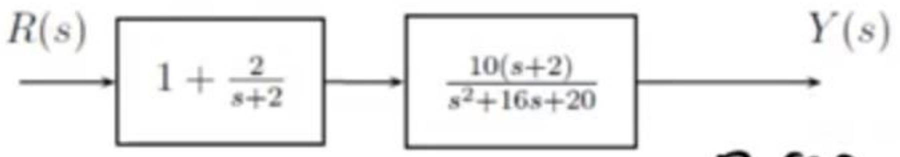




$$\frac{10(s+2)}{s^2+16s+20}$$

$$G(s) = \frac{10(s+2)}{s(s+6)}$$

$$H(s) = 1$$

$$\frac{\frac{10(s+2)}{s(s+6)}}{1+\frac{10(s+2)}{s(s+6)}} = \frac{10(s+2)}{s^2+16s+20}$$




$$R(s) = 1/s$$

$$\left.\frac{Y(s)}{R(s)}\right|_{N=0} = \frac{10(s+4)}{s^2+16s+20}$$

$$Y(s) = \frac{10(s+4)}{s(s^2+16s+20)} = \frac{2}{s} - \frac{1.45}{s+1.36} - \frac{0.54}{s+14.63}$$

$$y(t) = \mathcal{L}^{-1} Y(s) = 2u(t) - 1.45e^{-1.36} - 0.54e^{-14.63}$$

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$$\left.\frac{Y(s)}{E(s)}\right|_{N=0} = \frac{Y(s)}{R(s)-Y(s)} = \frac{A}{B-A}$$

$$\left.\frac{Y(s)}{R(s)}\right|_{N=0} = \frac{10(s+4)}{(s^2+16s+20)} = \frac{A}{B}$$

$$\left.\frac{Y(s)}{E(s)}\right|_{N(s)=0} = \frac{10(s+4)}{(s^2+16s+20)-10(s+4)} = \frac{10(s+4)}{s^2+6s-20}$$

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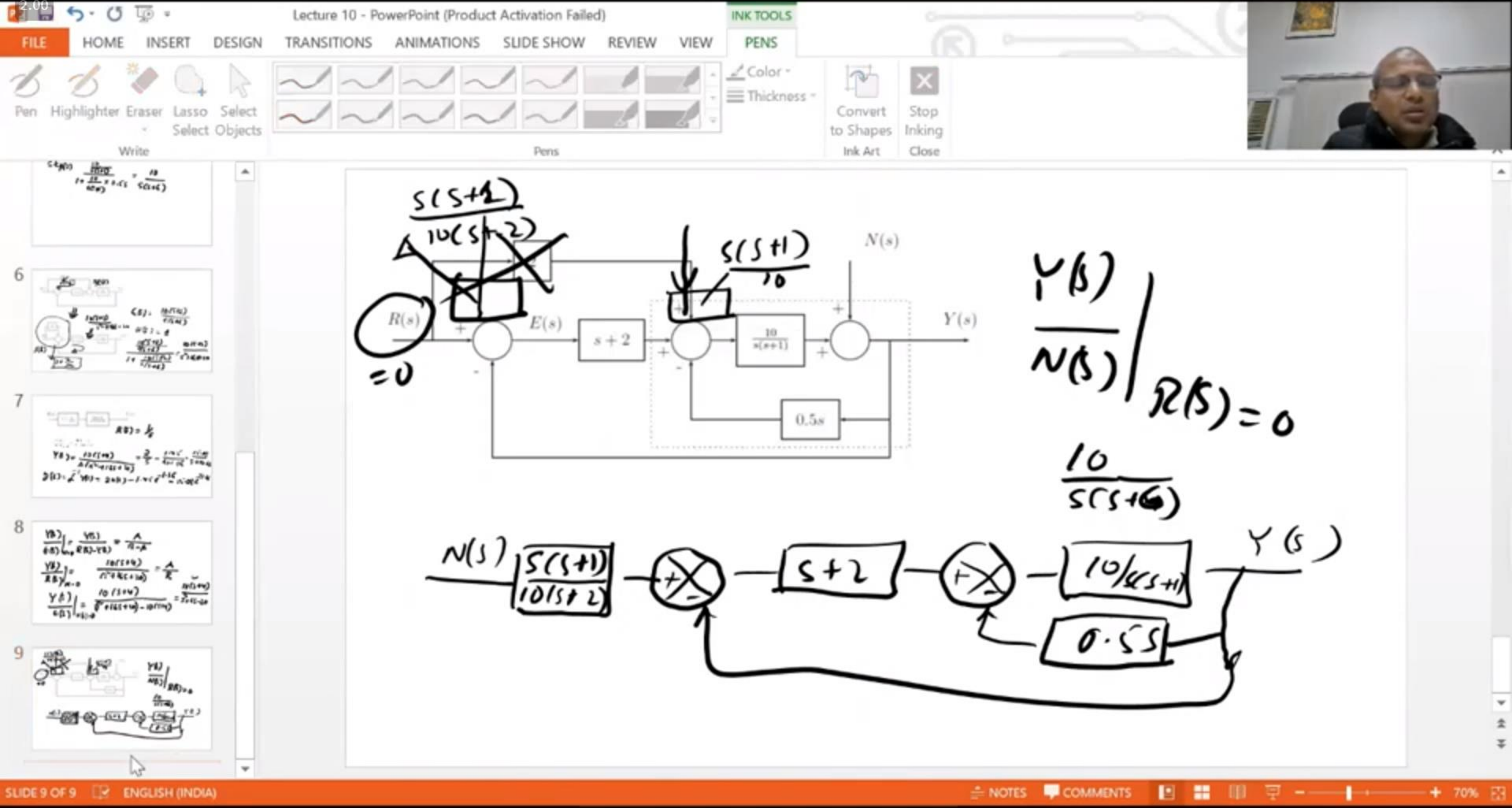
Lecture 10 - PowerPoint (Product Activation Failed)
FILE HOME INSERT DESIGN TRANSITIONS ANIMATIONS SLIDE SHOW REVIEW VIEW PENS
INK TOOLS
s(s+1) / 10(s+2)
N(s)
R(s)
=0
E(s)
s+2
10 / s(s+1)
0.5s
Y(s)
s(s+1) / 10
Y(s) / N(s) | R(s) = 0
10 / s(s+6)
N(s)
s(s+1) / 10(s+2)
s+2
10/s(s+1)
0.5s
Y(s)
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NOTES
COMMENTS
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$$N(s) - \boxed{\frac{s(s+1)}{10(s+2)}} - \boxed{\frac{10(s+2)}{s^2+16s+20}} - Y(s)$$

$$\left.\frac{Y(s)}{N(s)}\right|_{R(s)=0} = \frac{s(s+1)}{s^2+16s+20}$$

$$y(t) = u(t) + 0.03 \times e^{-1.36} + -15.03\, e^{-14.63}$$

$$n(t) = \delta(t), \quad N(s) = 1$$

$$Y(s) = 1 + \frac{0.03}{s+1.36} - \frac{15.03}{s+14.63}$$

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