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Lecture 10 - PowerPoint (Product Activation Failed)

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

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SLIDE 1 OF 5 ENGLISH (INDIA)

NOTES COMMENTS

70%

EE 250: Control Systems Analysis

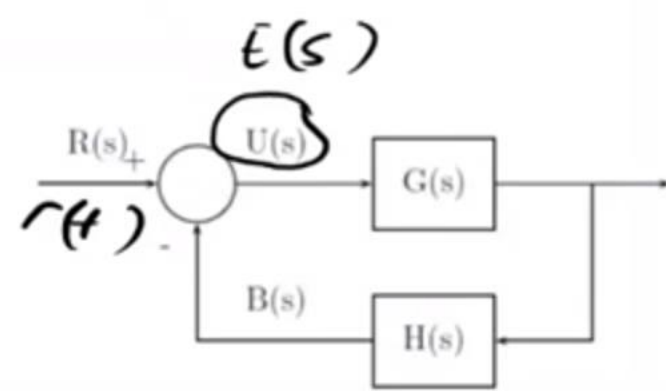
Module II: Block Diagram & SFG

Lecture 10: Block Diagram

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- 1 EE 250: Control Systems Analysis
Module II: Block Diagram & SFG
Lecture 10: Block Diagram
- 2
Handwritten notes on slide 2:
 $R(s) \leftrightarrow r(t)$ → command or reference signal
 $E(s) \leftrightarrow e(t) = r(t) - y(t)$ → error
 $G(s)$ → Forward gain → TF of the forward path
 $H(s)$ → TF of the feedback path
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$Y(s) \leftrightarrow y(t)$

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

$R(s) \leftrightarrow r(t)$ → command or reference signal

$E(s) \leftrightarrow e(t) = r(t) - y(t)$ ← error corrector loop

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

$G(s)$ → Forward gain → TF of the forward path

$H(s)$ → TF of the feedback path



- 1 EE 250: Control Systems Analysis
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- 2 $R(s)$ is the reference input, $E(s)$ is the error signal, $Y(s)$ is the output, $G(s)$ is the forward path transfer function, and $H(s)$ is the feedback path transfer function.
- 3 $Y(s) = G(s)E(s)$
 $E(s) = R(s) - H(s)Y(s)$
 $Y(s) = G(s)[R(s) - H(s)Y(s)]$
 $Y(s) = G(s)R(s) - G(s)H(s)Y(s)$
 $Y(s)[1 + G(s)H(s)] = G(s)R(s)$
 $\frac{Y(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$
- 4 $Y(s) = G(s)E(s)$
 $E(s) = R(s) - H(s)Y(s)$
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- 5 $Y(s) = G(s)E(s)$
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 $Y(s)[1 + G(s)H(s)] = G(s)R(s)$
 $\frac{Y(s)}{R(s)} = \frac{G(s)}{1 + G(s)H(s)}$

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

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

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

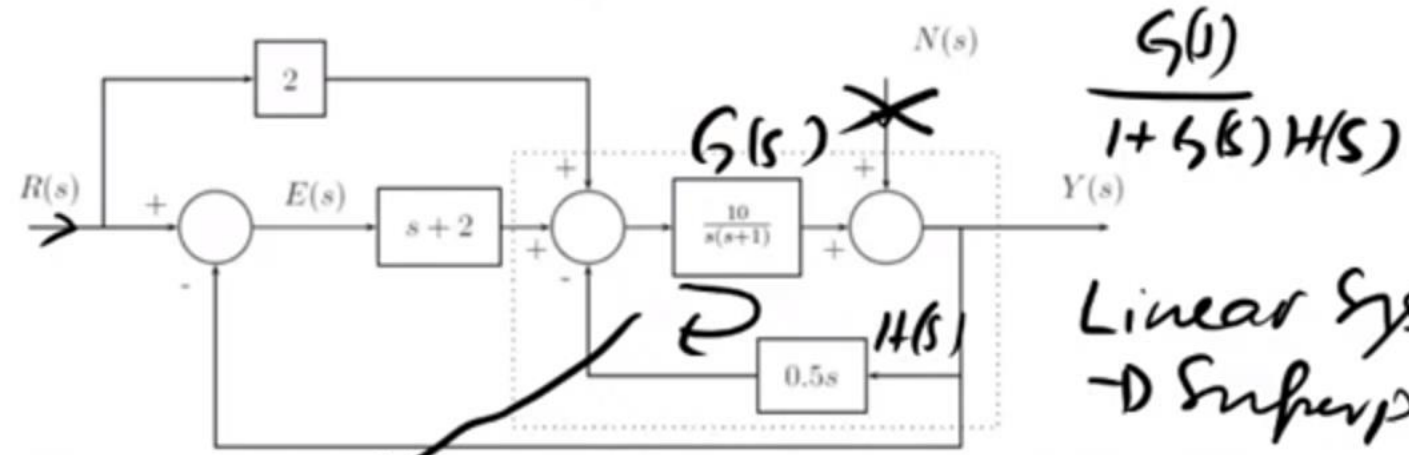
$$= G(s)R(s) - G(s)H(s)Y(s)$$

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

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



Simplify this Block diagram
& find



Linear System
→ Superposition

Find

$$\frac{10/s(s+1)}{1 + \left(\frac{10}{s(s+1)}\right) 0.5s} = \frac{10}{s(s+1)} R(s) \rightarrow Y_1(s)$$

$$N(s) \rightarrow Y_2(s)$$

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

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

- EE 250: Control Systems Analysis
Module II: Block Diagram & SFG
Lecture 10: Block Diagram
- Block diagram with handwritten notes: $R(s) \rightarrow Y(s)$, $E(s) = R(s) - Y(s)$, $Y(s) = G(s)E(s)$, $G(s) = \frac{10}{s(s+1)}$, $H(s) = 0.5s$.
- Block diagram with handwritten notes: $Y(s) = G(s)E(s)$, $E(s) = R(s) - Y(s)$, $Y(s) = G(s)[R(s) - Y(s)]$, $Y(s) = G(s)R(s) - G(s)Y(s)$, $Y(s) + G(s)Y(s) = G(s)R(s)$, $Y(s)[1 + G(s)H(s)] = G(s)R(s)$, $Y(s) = \frac{G(s)}{1 + G(s)H(s)} R(s)$.
- Simplify this Block diagram & find. Block diagram with handwritten notes: $Y(s) = \frac{10}{s(s+1)} E(s)$, $E(s) = R(s) - Y(s)$, $Y(s) = \frac{10}{s(s+1)} [R(s) - Y(s)]$, $Y(s) = \frac{10}{s(s+1)} R(s) - \frac{10}{s(s+1)} Y(s)$, $Y(s) + \frac{10}{s(s+1)} Y(s) = \frac{10}{s(s+1)} R(s)$, $Y(s) \left[1 + \frac{10}{s(s+1)} \cdot 0.5s \right] = \frac{10}{s(s+1)} R(s)$.
- Block diagram with handwritten notes: $Y(s) = \frac{10}{s(s+1)} E(s)$, $E(s) = R(s) - Y(s)$, $Y(s) = \frac{10}{s(s+1)} [R(s) - Y(s)]$, $Y(s) = \frac{10}{s(s+1)} R(s) - \frac{10}{s(s+1)} Y(s)$, $Y(s) + \frac{10}{s(s+1)} Y(s) = \frac{10}{s(s+1)} R(s)$, $Y(s) \left[1 + \frac{10}{s(s+1)} \cdot 0.5s \right] = \frac{10}{s(s+1)} R(s)$.



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Block diagram showing the transfer function $G(s) = \frac{10(s+2)}{s(s+6)}$ and the closed-loop transfer function $H(s) = \frac{10(s+2)}{s^2 + 16s + 20}$.

The diagram includes a feedback loop with a summing junction, a forward path with a block $\frac{10}{s(s+6)}$, and a feedback path with a block $\frac{2}{s+2}$.

Handwritten annotations include:

- $2R(s)$ (circled in red)
- $\frac{2}{s+2}$ (circled in red)
- $10(s+2)$ (circled in red)
- $s^2 + 16s + 20$ (circled in red)
- $1 + \frac{2}{s+2}$ (circled in red)

The final transfer function is given as:

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



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

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

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

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



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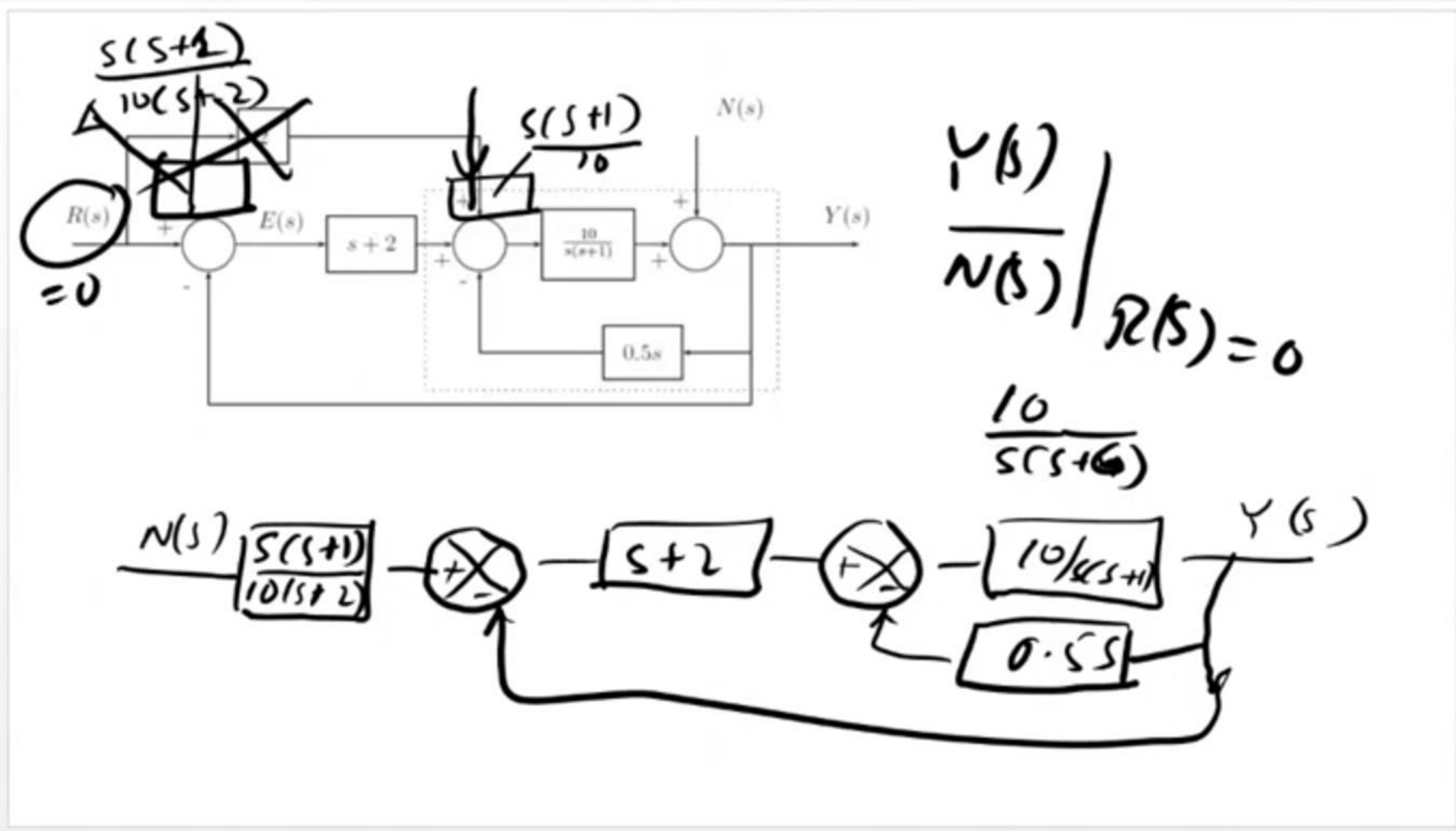
$$\frac{Y(s)}{E(s)} \Big|_{N(s)=0} = \frac{Y(s)}{R(s) - Y(s)} = \frac{A}{13 - A}$$

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

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



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$$\frac{Y(s)}{N(s)} \bigg|_{R(s)=0}$$

$$\frac{10}{s(s+1)}$$



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

$$\left. \frac{Y(s)}{N(s)} \right|_{R(s)=0} = \frac{s(s+1)}{s^2 + 16s + 20} \quad y(t) = 4(t) + 0.03xe^{-1.36t} - 15.03e^{-14.62t}$$

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

$$Y(s) = 1 + \frac{0.03}{s+1.36} - \frac{15.03}{s+14.62}$$