

2:00 Lecture 13 - PowerPoint (Product Activation Failed) INK TOOLS

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Layout Reset Section Slides

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Text Direction Align Text Convert to SmartArt

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EE 250: Control Systems Analysis

Module III: s-plane analysis

Lecture 13: Need for feedback control

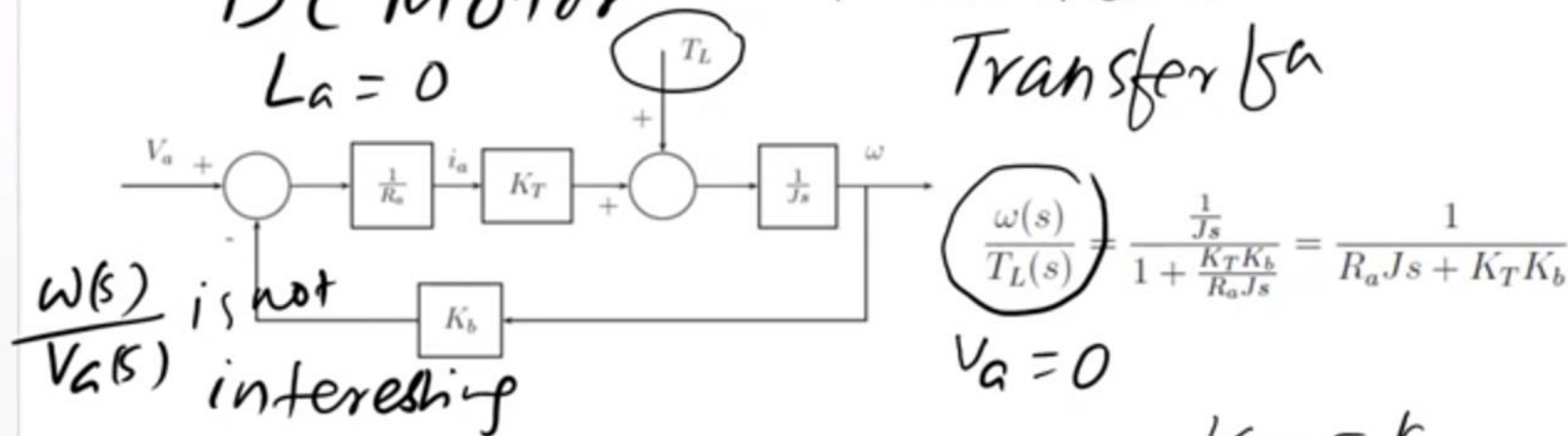
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- 1 EE 250: Control Systems Analysis
Module III: s-plane analysis
Lecture 13: Need for feedback control
- 2
- 3
- 4



1. Disturbance Rejection DC Motor Load disturbance Transfer function

$L_a = 0$



Given, $K_T = 1.5$, $R_a = 1\Omega$ and $J = 1$, we have

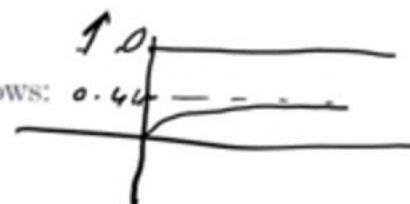
$$\frac{\omega(s)}{T_L(s)} = \frac{1}{s + 2.25}$$

For a unit step disturbance torque $T_L(s) = \frac{1}{s}$, output is evaluated as follows:

Desired $\omega_{ss} = 0$

$$\omega(s) = \frac{1}{s(s + 2.25)}$$

$$\Rightarrow w(t) = 0.444(1 - e^{-2.25t})$$

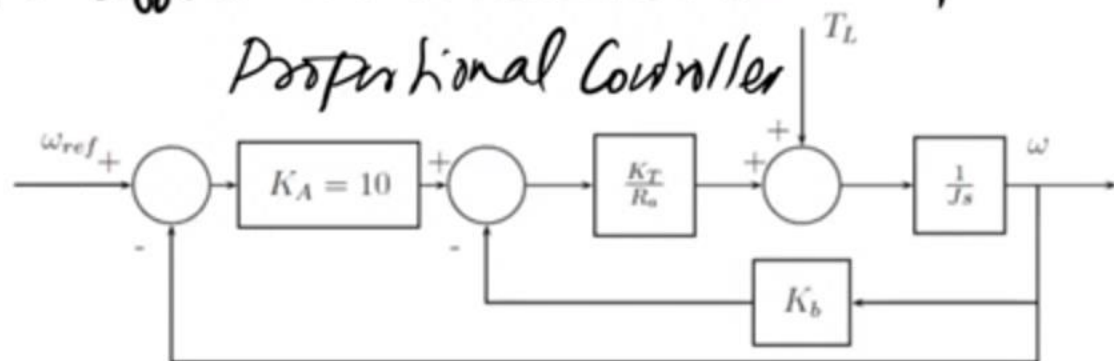


$$\omega_{ss} = 0.444$$



1. Effect on Disturbance Rejection

Proportional Controller



$$\frac{\omega(s)}{T_L(s)} = \frac{1}{s + 17.25}$$

$$T_L = \frac{1}{s}$$

$$\omega(s) = \frac{1}{s(s + 17.25)}$$

$$\Rightarrow w(t) = 0.0571(1 - e^{-17.25t})$$

$$w_{ss} = 0.0571$$

Without feedback

$$\frac{\omega(s)}{T_L(s)} = \frac{1}{s + 2.25}$$

$$w_{ss} = 0.444$$

$$\frac{\omega(s)}{T_L(s)} = \frac{\frac{1}{Js}}{1 + \frac{K_T K_b}{R_a Js} + \frac{K_T K_A}{R_a Js}}$$

$$= \frac{s}{s^2 + 2.25s + 15}$$

$$K = \frac{10}{s}$$

$$T_L = \frac{1}{s}$$

$$\omega(s) = \frac{1}{s^2 + 2.25s + 15}$$

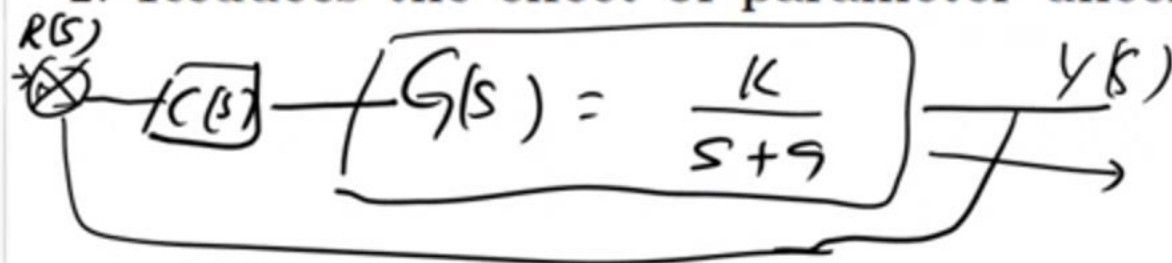
$$\Rightarrow \omega(t) = 0.2698e^{-1.125t} \sin(3.7059t)$$

$$w_{ss} = 0$$

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1. Effect on Disturbance Rejection
Proportional Controller
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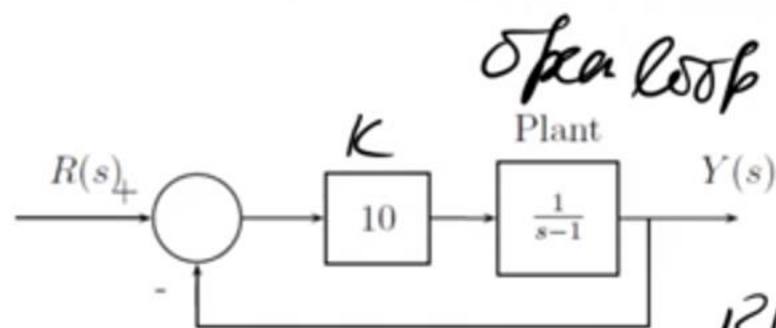


2. Reduces the effect of parameter uncertainties



$$\frac{K}{s+9.1} \text{ or } \frac{K}{s+8.9}$$

3. Provides stability to an open-loop unstable system



open loop unstable

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

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

$$\frac{Y(s)}{R(s)} = \frac{10}{s+9}$$

$$e^t$$

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

$$Y(s) = \frac{10}{s(s+9)}$$

Stable system

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New Slide

Add Section



- EE 250: Control Systems Analysis
Module III: s-plane analysis
Lecture 13: Need for feedback control
- Block diagram of a feedback control system with a disturbance input. The system is represented by blocks $G(s)$ and $H(s)$. The disturbance input is $d(s)$. The output is $y(s)$. The error signal is $e(s)$. The feedback signal is $y(s)H(s)$. The control signal is $u(s)$. The system is a negative feedback system.
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- Given transfer function $G(s)$, the closed loop feedback control system has the following properties:
→ Disturbance rejection
→ Reduces the effect of parametric uncertainties
→ Stabilizes

Given open loop $G(s)$,
the closed loop feedback control

→ Disturbance rejection

→ Reduces the effect of parametric uncertainties

→ Stabilizes