4.2.1 Lecture Quiz Week 4

Why does closed-loop control reduces control errors? Prove it by deriving the closed-loop transfer function and analysing the relation between the output y and reference u. See Figure 1 below for the notation in questions 1-8.

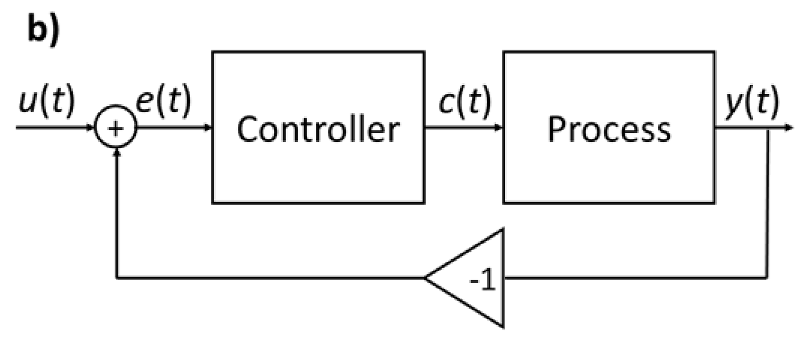

Figure 1. Closed-loop system

Question 1 29 / 29
The **open**-loop transfer function equals to $C(s)$ for Controller and $P(s)$ for Process. Note you need to **cut** feedback loop for open-loop analysis.

- $U(s) - E(s) = C(s)Y(s)$
- $y(t) * u(t) = 0$
- $\frac{Y(s)}{U(s)} = C(s)P(s)$

Question 2 29 / 29
The **closed**-loop transfer function equals to

- $\frac{Y(s)}{U(s)} = \frac{C(s)P(s)}{C(s)P(s)}$
- $\frac{Y(s)}{U(s)} = \frac{C(s)P(s)}{1+C(s)P(s)}$
- $\frac{Y(s)}{U(s)} = \frac{C(s)P(s)}{1-C(s)P(s)}$

Question 3 29 / 29
If the controller C is a large number, the relative tracking error y/u becomes... Note: Assume that the system remains stable even when the controller gain is large

- ...extra large
- ...large
- **...small**

Question 4 29 / 29
On the other hand, if the controller C is a small number, the tracking error becomes...

- ...very small
- **...large**
- ...small

Design a proportional speed controller for a wheel with inertia J. For a unit step in speed command, 63 % of the command value needs to be achieved in 1 second. Derive the proportional gain K (=controller). The plant (=process) equals to:

$T = J\dot{\omega}$

The system looks like in Figure 1 above.

This course has already ended.

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Lecture Quiz 4

Points 0 / 350 My submissions 0 / 2 ▾

The deadline for the assignment has passe

Why does closed-loop control reduces control er … e Figure 1 below for the notation in questions 1-8.

Question 1 29 points
The **open**-loop transfer function equals to $C(s)$

- $U(s) - E(s) = C(s)Y(s)$
- $y(t) * u(t) = 0$
- $\frac{Y(s)}{U(s)} = C(s)P(s)$

Question 2 29 points
The **closed**-loop transfer function equals to

- $\frac{Y(s)}{U(s)} = \frac{C(s)P(s)}{C(s)P(s)}$
- $\frac{Y(s)}{U(s)} = \frac{C(s)P(s)}{1+C(s)P(s)}$
- $\frac{Y(s)}{U(s)} = \frac{C(s)P(s)}{1-C(s)P(s)}$

Question 3 29 points
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$T = J\dot{\omega}$

The system looks like in Figure 1 above.

Question 5 29 points
What the system is in Laplace domain as transfer function (open loop control)? (Calculate the transfer function from torque to angular speed.)

- $\frac{\omega(s)}{T(s)} = Js$
- $\frac{\omega(s)}{T(s)} = \frac{1}{Js^2}$
- $\frac{\omega(s)}{T(s)} = \frac{1}{Js}$

Question 6 29 points
The closed loop system equals to

- $\frac{y(s)}{u(s)} = \frac{K/J}{s+K/J}$
- $\frac{y(s)}{u(s)} = \frac{K}{K/J}$
- $\frac{y(s)}{u(s)} = \frac{1}{s+KJ}$

Question 7 29 points
The rise time of the system is...

- 1 second
- 0.1 second
- 10 seconds

Question 8 29 points
What is the proportional gain K of the system? It is based on the time constant.

- $K = 1$
- $K = J$
- $K = Js$

If you would code a PID controller, then what do you need to define and how? Please answer in the tasks below.

Question 9 29 points
The code for digital PID controller needs to have the following information

- Corresponding P, I, and D gains, sample time, and signal values for one time step
- Corresponding P, I, and D gains, sample time, and signal values for two successive time steps
- Corresponding P, I, and D gains, sample time, and signal values for three successive time steps

Question 10 29 points
The derivative term can be expressed as...

Notation:
K_d: derivative gain
Δt: sample time
$u(t)$: signal to be derived at time instant t

- $K_d(u(t) - u(t - \Delta t)) * \Delta t$
- $K_d u(t)$
- $K_d \frac{u(t)-u(t-\Delta t)}{\Delta t}$

Question 11 30 points
The integral term can be expressed...

Notation:
K_I: integral gain
Δt: sample time
$u(t)$: signal to be integrated at time instant t

Assume previous integral value is added later on the integral term you select

- $K_I \frac{u(t)+u(t-\Delta t)}{2} \Delta t$
- $K_I(u(t) - u(t - \Delta t))$
- $K_I u(t)$

Question 12 30 points
The proportional term can be expressed

Notation:
K_p: proportional gain
Δt: sample time
$u(t)$: signal at time instant t

- $K_p K_I K_d u(t)$
- $K_p u(t)$
- $K_I u(t)$

Submit

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