Cairo University

Faculty of Engineering

Computer Engineering Department

ELC3252 Project

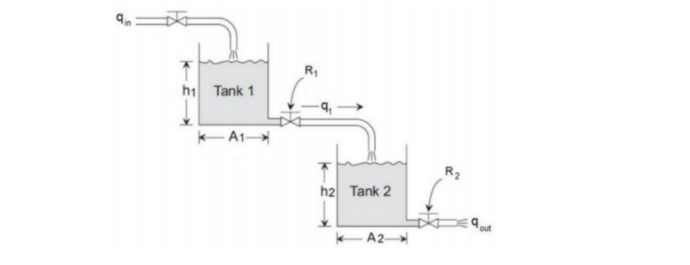
Group No. 8

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1. Transfer Functions (Hand analysis):

A₁ = 5, A₂ = 4, R₁ = 3, R₂ = 5

## Equations:

→ Qin - Q₁ = A₁ s H₁

→ Q₁ - Q₀ = A₂ s H₂

→ H₁ - H₂ = R₁ Q₁

→ H₂ = R₂ Q₀

**b) Transfer Functions:**

1. Transfer functions (MATLAB):

A math equations and numbers

AI-generated content may be incorrect.A math equations with numbers and lines

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A math equations and numbers

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1. System stability:

* **Hand Analysis:** Check poles’ locations of the c/c eqn.
* **Verification with MATLAB:**

A graph with lines and numbers

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* **Conclusion:** poles are in the LHP → System is stable.

1. Step responses:

A graph of a step response

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**Notice how the system is over damped:**

→ overdamped system.

1. Tracking input Hd:

Use P-controller (kp = 1)A diagram of a machine

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1. H1 & H2 for Hd = 5m:

where

For kp = 1 →

A graph with a line graph

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1. H2 response calculations:

A graph of a step response

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* Natural frequency:
* Damping ratio:

→ Under damped

* Peak time:
* Relative overshoot:
* Rise time:
* Settle time:
* Steady state error: type\_0 system, step input:

1. Effect of Kp on tracking hHHd:
2. **For kp = 1:**

* Natural frequency:
* Damping ratio:

→ Under damped

* Peak time:
* Relative overshoot:
* Rise time:
* Settle time:
* Steady state error:

1. **For kp = 10:**

* Natural frequency:
* Damping ratio: = 0.243

→ Under damped

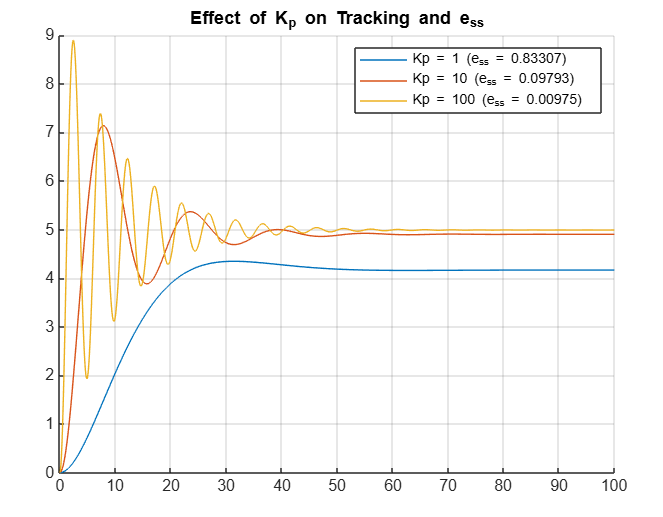
* Peak time:
* Relative overshoot:
* Rise time:
* Settle time:
* Steady state error:

1. **For kp = 100:**

* Natural frequency:
* Damping ratio:

→ Under damped

* Peak time:
* Relative overshoot:
* Rise time:
* Settle time:
* Steady state error:



### Effect of Increasing Kp​ on System Performance:

* **Damping Ratio:**

The damping ratio decreases proportionally with .

* Damped Natural Frequency **​:**

The damped natural frequency increases with higher .

* Relative overshooting:

The relative overshoot increases due to the reduced damping ratio .

* Peak time:

The peak time decreases because the system responds faster.

* Rising time:

The rise time decreases, reflecting quicker initial response.

* Steady state error:

The steady state error for a step input decreases with higher *.*

* Settle time:

The settling time remains relatively unaffected by .

While ​ increases, the reduction in  counterbalances its effect, leaving ​ approximately constant.

1. P-Controller in Error Reduction:

### Can reach error < 0.01 with P-Controller only if kp > 99.8

1. Eliminate ess, H2 = 6:

* **Requirements:**

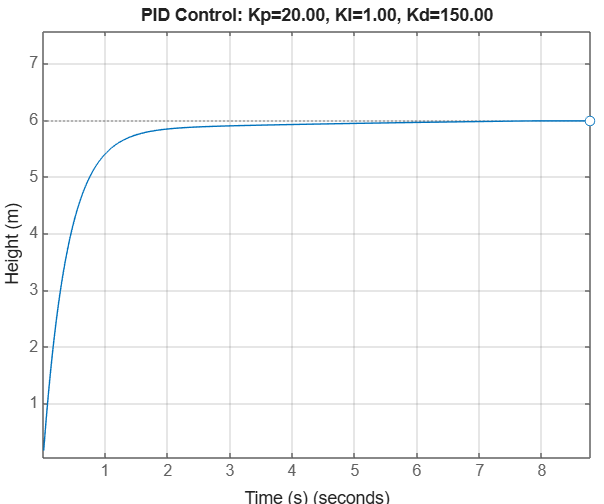
1. Eliminate ess → PI-Controller
2. Reduce Mp as tank’s height = 6 m → PD controller

Use PID-controller

A diagram of a chemical reaction

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* **Error analysis:**



A math equations with lines and numbers

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* **Check stability:**

bc > ad → stable

error eliminated.

overshoot eliminated.