Process Dynamics & Control

For GATE-2019

Chemical Engineering

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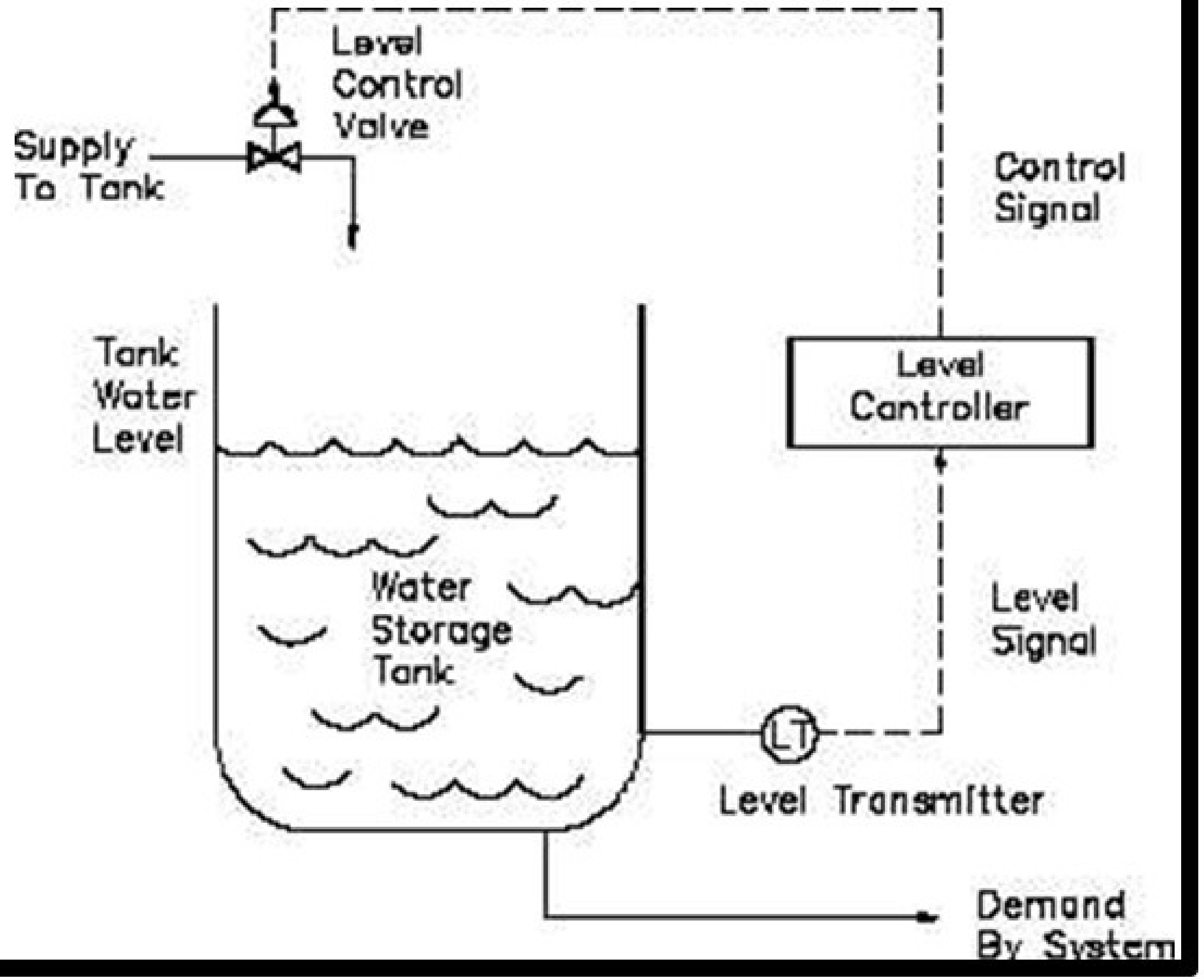
Process Dynamics & Control

Lesson 21

Multi-capacity System- Part 1



#My Courses on Unacademy

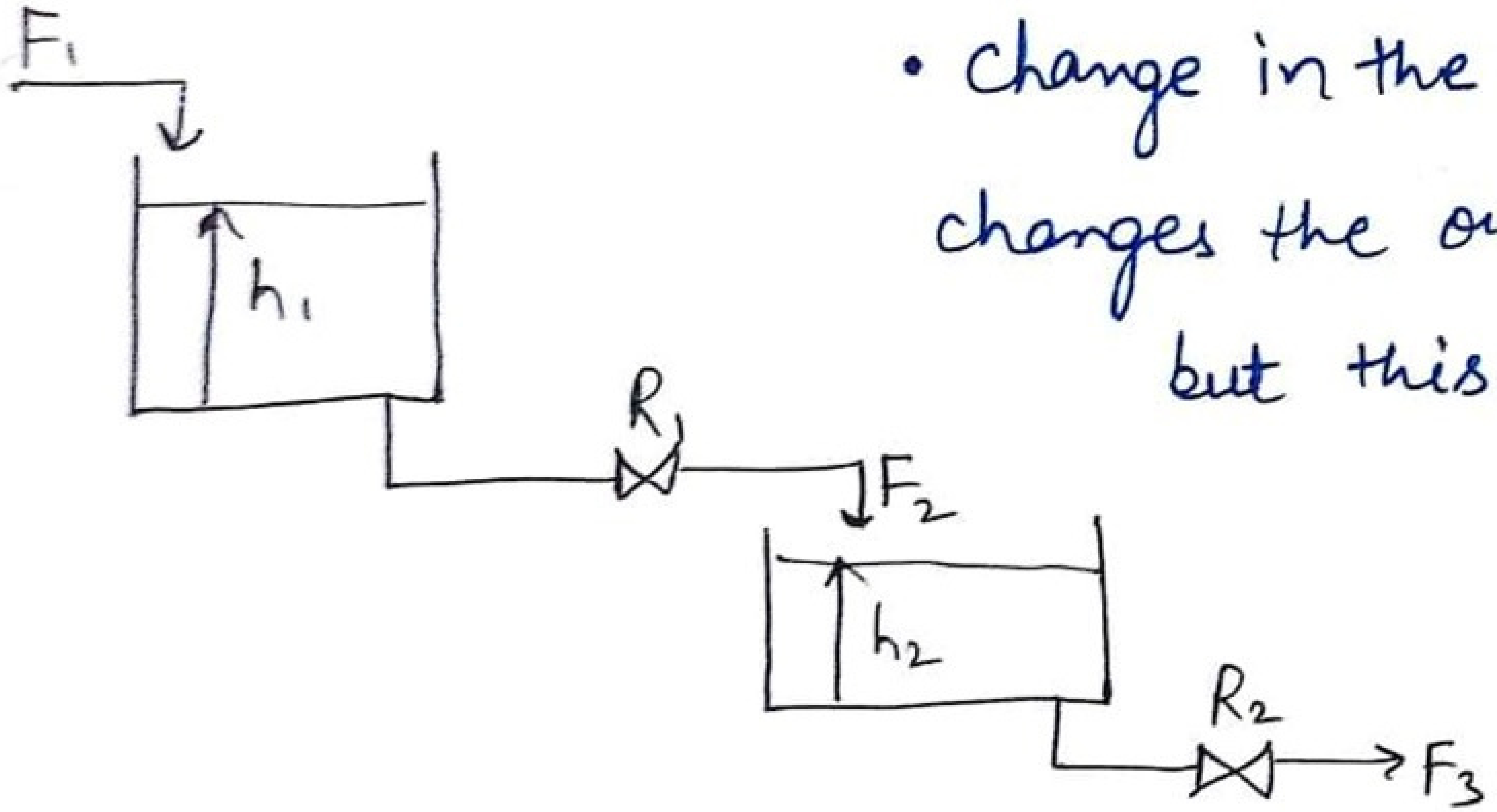
- Process Calculations for GATE (Chemical Engineering)-2019
- Preparation Strategy for GATE (Chemical Engineering)-2019 with most important topics.
- Heat Exchangers
- Radiation Heat Transfer for GATE-2019 exam.
- Transportation and Metering of Fluids for PSU Interviews -2018.
- Non-Ideal Reactors for GATE-2019.
- Mass Transfer Equipment for PSU Interviews -2018.
- Chemical Reaction Engineering- Part 1
- How to get Best Rank in GATE 2019 Chemical Engineering

Target Audience

All undergraduate Chemical Engineering Students

GATE- (Chemical Engineering) aspirants

Non-Interacting Systems :-



- change in the output of first tank, changes the output of second tank but this is not vice versa.

Applying balances,

$$F_1 - F_2 = A_1 \frac{dh_1}{dt} \quad \text{— for tank 1}$$

$$F_2 - F_3 = A_2 \frac{dh_2}{dt} \quad \text{— for tank 2}$$

We also ~~t~~know that, $F_2 = \frac{h_1}{R_1}$ & $F_3 = h_2/R_2$

Now,

$$F_1 - \frac{h_1}{R_1} = A_1 \frac{dh_1}{dt} \Rightarrow A_1 R_1 \frac{dh_1}{dt} = F_1 R_1 - h_1 \quad \text{— (3)}$$

$$F_2 - \frac{h_2}{R_2} = A_2 \frac{dh_2}{dt} \Rightarrow A_2 R_2 \frac{dh_2}{dt} = F_2 R_2 - h_2 \quad \text{— (4)}$$

from (3) :

$$\tau_{p1} \frac{dh_1}{dt} + h_1 = F_1 R_1$$

writing down equations in terms of deviation variables.

We get $$\frac{F_2(s)}{F_1(s)} = \frac{1}{\tau_{p_1} s+1} \checkmark \quad \text{—— (5)}$$

Similarly for tank (2), we get,

$$\frac{H_2(s)}{R_2(s)} = \frac{R_2}{\tau_{p_2} s+1} \checkmark \quad \text{—— (6)}$$

Combining (5) & (6), we get.

$$\boxed{\frac{H_2(s)}{R_1(s)} = \frac{R_2}{(\tau_{p_1} s+1)\,(\tau_{p_2} s+1)} = \frac{R_2}{\tau_{p_1}\tau_{p_2} s^2+(\tau_{p_1}+\tau_{p_2}) s+1}}$$

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Comparing the equation with 2nd order T.F.

$$\tau^2 = \tau_{p_1} \tau_{p_2} \Rightarrow \boxed{\tau = \sqrt{\tau_{p_1} \tau_{p_2}}}$$

Natural Period of oscillation.

$$\boxed{\tau = \text{G.M. of } (\tau_{p_1}, \tau_{p_2})}$$

τ for non-interacting systems is the G.M. of time constants.

Also, $2\xi\tau = \tau_{p_1} + \tau_{p_2}$

$\xi = \dfrac{(\tau_{p_1} + \tau_{p_2})}{2\tau} = \dfrac{A.M.}{G.M}$ of time constants

$\boxed{A.M. > G.M}$ Always

$\xi \geq 1$ (Hence, ξ can not be less than 1)

because. if overdamped system is present, it can remain overdamped or critically ~~cto~~ damped but can't change the domain).

Thanks!

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Any questions?