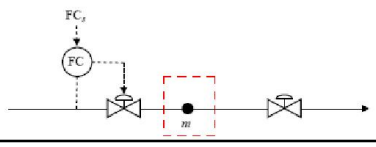
Plantwide control, energy and orienteering challenge

$$g(s) = \frac{-0.25s+1}{3s(s+1)}$$

DIPLOMA

Plantwide control, energy and orienteering challenge

WINNER



$$g(s) = \frac{-0.25s+1}{3s(s+1)}$$

DIPLOMA

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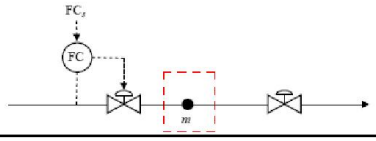
LOOSER

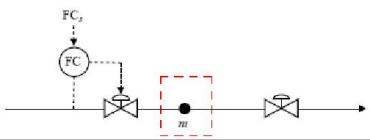


$$g(s) = \frac{-0.25s+1}{3s(s+1)}$$

DIPLOMA

Plantwide control, energy and orienteering challenge

PARTICIPANT



- 5 teams
- 5 posts in different order + return here (K5)
- Solve 6 problems + minimize time
- Max 10 points for each problem
- Max 20 points for time
  - Fastest team to return gets 20 points, slowest 0 points
- Other rules
  - Must hand in solution before getting next post and problem
  - If need help for finding posts or solving problems, call 91371669 (1 min added to time per call)
  - Can otherwise use any help (except from PhD students)

- Team 1 (no.2, Runner-up; best on time, 59/80)
  - Manfred
  - Elling
  - Audun
  - (Federico)
- Team 2 (no.5, "Looser"/Loser, last on time, 43/80)
  - Ian
  - (Morten)
  - Marius
  - Magnus
- Team 3 (no. 4)
  - (Heinz)
  - Petter
  - Deep
  - Maryam
- Team 4 (no.3)
  - Magne
  - (Nadi)
  - (Truls)
  - Stathis
  - Esmaeil
- Team 5 (no.1, Winner team, 61/80)
  - Krister
  - Ivar
  - Vidar

- Posts:

1. R10 (Vlad)
2. NTVA (Chriss)
3. Sem Sælands vei 14 (Adriana)
4. Cybernetics (Julian)
5. Main building (Vini)
6. K5 (return) (Sigurd, Johannes)

- Team 1: 1, 2, 3, 4, 5, 6
- Team 2: 3, 2, 1, 4, 5, 6
- Team 3: 2, 1, 3, 5, 4, 6
- Team 4: 4, 5, 1, 2, 3, 6
- Team 5: 5, 4, 3, 2, 1, 6

Team: **Post: R10**

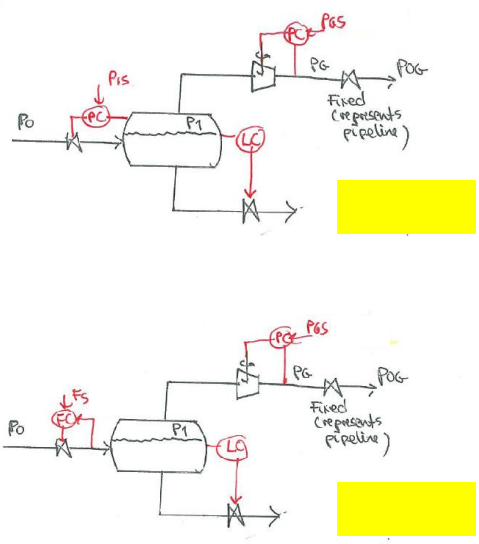
Problem 1. PI tuning

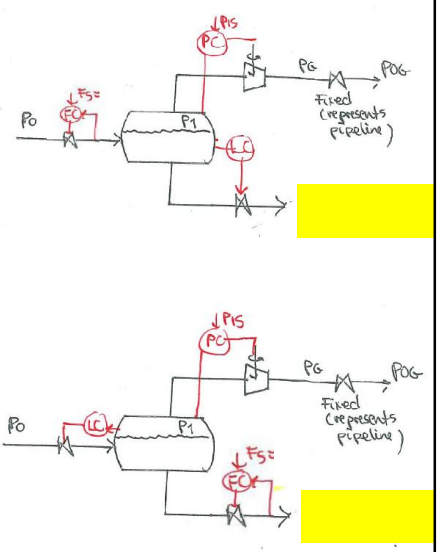
Propose PI-settings (K_c and τ_I) for the following process:

$$g(s) = \frac{-0.25s+1}{3s(s+1)}$$

Team: **Post: NTVA**

Problem 2. Does it work? Yes or No





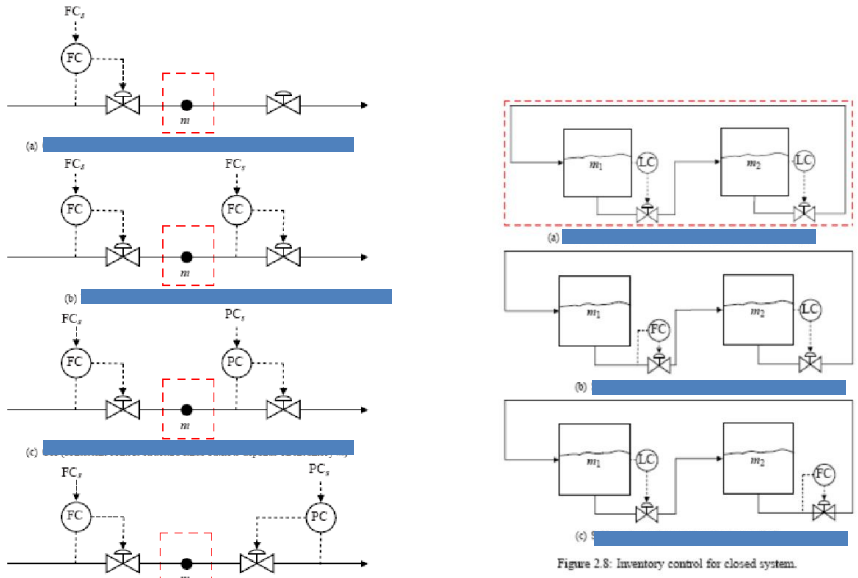


Figure 2.8: Inventory control for closed system.

Team: **Post: Sem Sælands vei 14**

Problem 3. Distillation

- Separation of heavy water from water by distillation is difficult because the difference in boiling point is only 1.4C (relative volatility 1.05). Consider a feed mixture with 1% heavy water and 99% water
- (a) What is the minimum* no. of theoretical stages to get a heavy water product of 90% purity and a water product of 99.9% purity?
- (b) What if the heavy water should have 99% purity? How large (in %) is the increase in (b1) no. of stages, and (b2) energy usage (Vmin)?

* This is with infinite energy (reflux). In practice, we need about 2-3 times as many stages

Team: **Post: Cybernetics**

Problem 4. RGA

G =

1.1	2	4	5
-1	0	0	5
2	4	7	9
10	10	0	1

RGA=G.*inv(G)'

5.0000	-9.2727	0.7273	4.5455
-0.1039	0	0	1.1039
-5.1948	x	0.2727	-4.6753
1.2987	-0.3247	0	0.0260

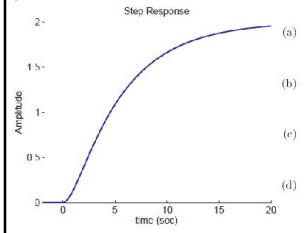
(a) What is x in the RGA?
(b) What pairings would you suggest? (circle pairings on G- or RGA-matrix)
(c) The 1,1-element in G is changed. What value makes G singular?

Team: **Post: Main building**

Problem 5. Transfer functions

Which one is the correct transfer function? Circle the correct alternative.
Note: None of the alternatives or more than one are possible answers

I)



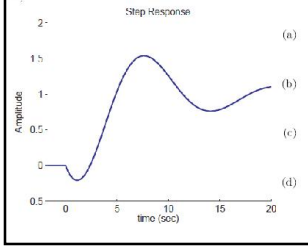
(a) $\frac{2}{(5s+1)(s-1)}$

(b) $\frac{2}{(5s+1)^2}$

(c) $\frac{1}{(5s+1)} \cdot \frac{1}{s+1}$

(d) $\frac{2}{5s-1}$

II)



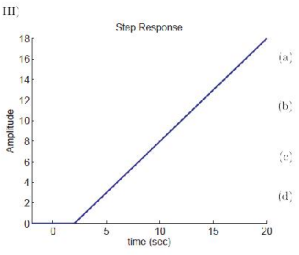
(a) $\frac{-0.5}{s+1} + \frac{1.5}{4s+1}$

(b) $\frac{-1.5s}{4s^2+4s+1}$

(c) $\frac{1.5s-1}{4s^2+4s+1}$

(d) $\frac{-1.5s+1}{4s^2+4s+1}$

III)



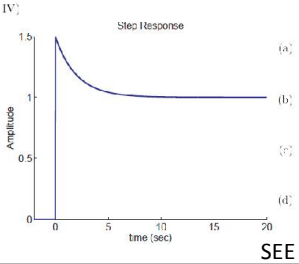
(a) $\frac{1}{s}$

(b) $\frac{e^{-2s}}{s}$

(c) $e^{-2s} + 1/s$

(d) $\frac{2e^{-2s}}{s}$

IV)



(a) $\frac{1}{(2s+1)(3s+1)}$

(b) $\frac{3s+1}{2s+1}$

(c) $1.5 - \frac{0.5}{2s+1}$

(d) $\frac{2s+1}{3s+1}$

SEE NEXT PAGE!

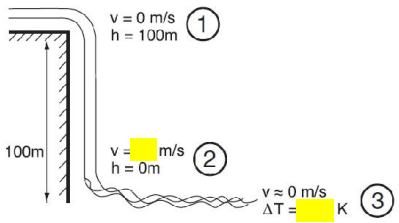
V) $y = g_1(s)\, u$

Write the analytic expression for $y(t)$ for a unit step in the input ($u = 0$ for $t < 0$, $u = 1$ for $t \geq 1$).

$$g_1(s) = \frac{1}{\tau_1 s + 1} \qquad (2)$$

Team: **Post: K5**

Problem 6. Energy



Waterfall: (1) potential energy -> (2) kinetic energy -> (3) thermal energy

- Fill in the two missing numbers
- Last post. Please return to K5!