Cairo University
Faculty of Engineering
Computer Engineering Department

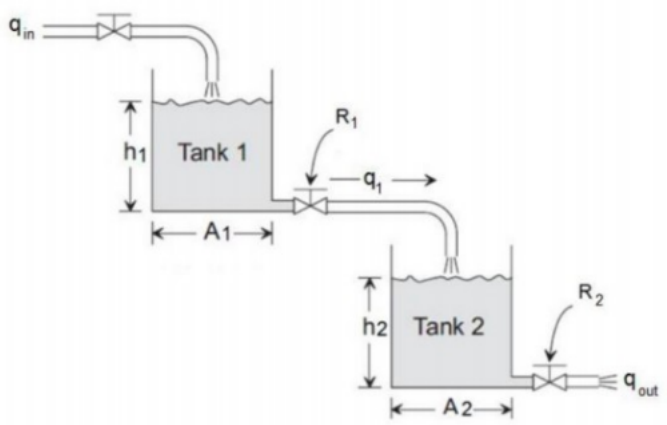
Spring Semester 2025

Course Code:	ELC 3252
Course Title:	Control Engineering
Course Instructors:	Prof. Dr. Ragia Badr - Dr. Meena Elia
Course TA:	Eng. Hassan El-Menier

Project: Due on Tuesday, 6^{th} of May, 2025 at 10:00 PM

Question (1):

For the two-tank system shown below:



1. Write the dynamic equations of the system and use it to drive the block diagram representation of the system (hand analysis). Don't perform any reduction to the block diagram.

2. Use Matlab to enter your detailed block diagram and then use Matlab commands to obtain the following transfer functions: $\frac{Q_o}{Q_{in}}, \frac{Q_1}{Q_{in}}, \frac{H_1}{Q_{in}}, \frac{H_2}{Q_{in}}$

   The system parameters are as follows:

   - Area of the first tank is $5m^2$
   - Area of the second tank is $4m^2$
   - Resistance of the first valve is $3s/m^2$
   - Resistance of the second valve is $5s/m^2$

3. For any of the above transfer functions $\left(i.e. \frac{H_2(s)}{Q_{in}(s)}\right)$ study the stability of the system (using poles location).

4. The system is then operated by applying a fixed input flow of $1m^3/s$. Simulate the system under this value of input flow showing the response of $h_1, h_2, q_{in}, q_{out}$, also from the resulting responses calculate the steady state value of these signals.

5. Suggest a modification to the system such that: the system input is a certain desired level h_d (reference input) and the liquid level in the second tank h_2 is required to follow this desired level h_d (Hint: Use Feedback concept).
6. Simulate the system for a desired level (h_d) of $5m$ showing the response of h_1, h_2.
7. For the response of h_2, calculate the value of the rise time, peak time, max peak, and settling time. Also calculate the value of e_{ss}.
8. As a solution to reduce the value of e_{ss}, a proportional controller can be used. Study the effect of the value of proportional controller on both e_{ss} and transient response by simulating the system with the following values of P controller: 1, 10, 100. Calculate transient response parameters for each case. Comment on your results.
9. If the actual height of the second tank walls is $6m$, is it possible to obtain a steady state error less than 0.01 using a proportional only controller? Why?
10. Suggest a suitable controller to eliminate e_{ss}. Then, simulate the system using your proposed controller. **Hint**: Get controller constants by try and error, knowing that height of the second tank is $6m$.

Guidelines

1. The number of group members is up to **4** students.
2. You can use either MATLAB or Simulink for your simulations.
3. Delivery requirements:
   (a) Include all the hand analysis and MATLAB/Simulink simulations with results and your analysis in a pdf file.
   (b) Add the pdf file along with the MATLAB files in a zip folder.
   (c) The format of the folder should be `ELC3252_Project_Gp_[Group No.]` (ex: `ELC3252_Project_Gp_7`).
   (d) Only one folder to be submitted per group.
4. The deadline is on **Tuesday,** 6^{th} **of May, 2025** at **10:00 PM**.
5. Duplicated/Late submissions will receive **ZERO** mark.