Cairo University
Faculty of Engineering
Credit Hours System
Communications and Computer Engineering Department

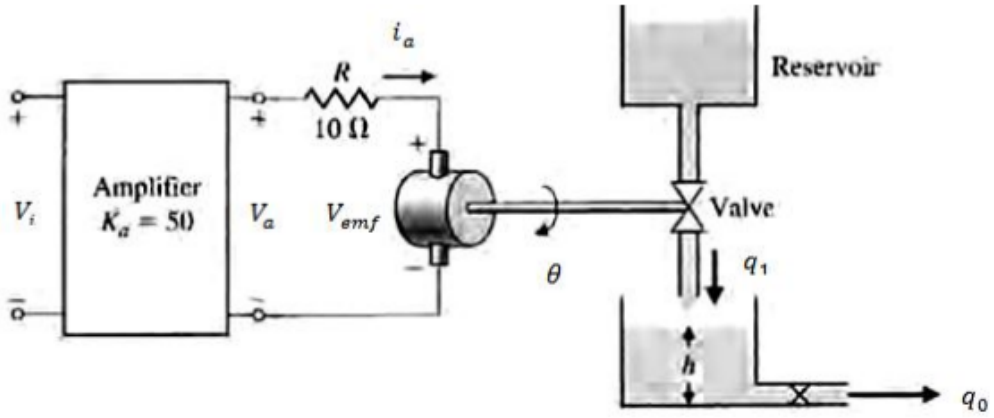
Spring Semester 2023

Course Code	ELCN304
Course Title	Control-1
Course Instructors	Prof. Dr. Ragia Badr - Dr. Meena Elia
Course TA	Eng. Hassan El-Menier

Project: Due on Firday, 5^{th} of May, 2023 at 10:00 PM

Question (1):

For the system shown below, neglect the motor inductance ($L_m = 0$), the torque constant is $K_T = 9.5$, the back-emf constant is $K_b = 0.0704$. The motor inertia equals the valve inertia, $J = 0.0058$, and the area of the tank is $51m^2$. Assume that $q_1 = 82\theta$, where θ is the motor shaft angle. The output flow is $q_o = 51h(t)$:

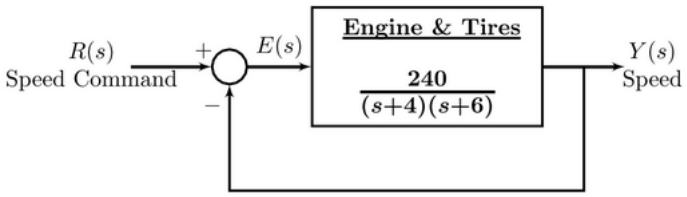


1. Write the dynamic equations of the system and use it to build a state space representation for the system (hand analysis).
2. Check the Controllability and the Observability of the system using MATLAB.
3. Use MATLAB/Simulink to enter your state space representation and then use MATLAB commands to obtain the transfer function $\frac{H(s)}{V_i(s)}$
4. Study the stability of the system (using poles location).
5. The system is then operated by applying a fixed input voltage of $1V$. Simulate the system response under this value of input voltage. Hence, from the resulting response, calculate the steady state value of the output signal. Comment on your results.
6. 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 tank h is required to follow this desired level h_d.

7. Study the effect of adding the following controller $\frac{G_c(s)}{s+1000}$, where $G_c(s) = 1$, to the system. Plot the step response of the output h, then calculate the value of the rise time, peak time, settling time, maximum overshoot and the value of e_{ss}. Comment on your results.
8. Suggest a controller $G_c(s)$ to satisfy settling time less than 3 sec and maximum overshoot less than 15%.

Question (2):

The engine, body, and tires of a racing vehicle affect the acceleration and speed. The car model can be represented by the model shown in the following figure:



Using MATLAB/Simulink answer the following:

1. Measure the steady-state error of the car to a step command in speed, and the overshoot of the speed.
2. Suggest and design a controller such that reject the steady-state error and reduce the overshoot in (1).
3. Measure the resultant overshoot and the settling time.

Guidelines

1. The number of group members is 4 to 5 students.
2. The groups can be formed independent of the registration whether in lectures or tutorials.
3. You can use either MATLAB or Simulink for your simulations.
4. Delivery requirements:
   (a) Include all the hand analysis and MATLAB/Simulink simulations with results and your analysis in a pdf file.
   (b) The format of the pdf file should be `ELCN304_Project_Gp_[Group No.]` (ex: `ELCN304_Project_Gp_7`).
   (c) Only one soft copy to be submitted per group.
5. The deadline is on **Firday,** 5^{th} **of May, 2023** at **10:00 PM**.
6. Duplicated/Late submissions will receive **ZERO** mark.