**EEE 342** **Spring 2019**

## Lab-3 Preliminary Work Manual

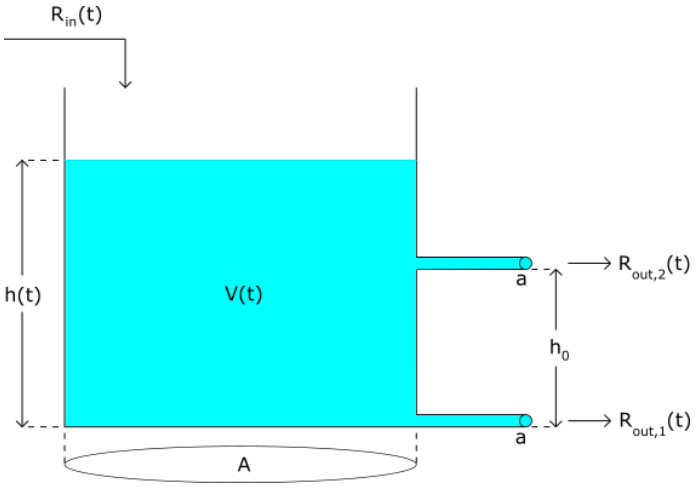
The aim of this preliminary work is to encourage the students to think about, as well as to improve their ability in identifying and formulating, real life engineering problems and to propose possible solutions for them considering various issues (e.g. economic, political, social, environmental, etc.) which are possibly related to the problem in question.

The problem in question is related to the so-called Nabucco gas pipeline project. For more information related to the project as well as the proposed pipeline route, refer to the public sources, e.g. internet, library, newspapers, etc. By considering the possible route of the pipeline, only one gas storage / distribution station is going to be built in Turkey.

1. Propose a possible geographical location of the gas storage tank based on economic, political, social, environmental issues etc. Write a detailed discussion on your choice and selected criterions and use visuals when necessary.

2. Discuss and identify possible problems which may be encountered during the gas storage/distribution process. Try to identify the problems which can be solved by engineering techniques and the ones which possibly cannot. Define two problems for each of engineering and non-engineering areas, including your solution proposals.

3. The following system will be designed to store the incoming gas ($R_{in}(t)$) and control the output to both Turkey and Europe ($R_{out,1}(t)$ and $R_{out,2}(t)$ respectively). In the diagram, *A* denotes the base area and *a* is the pipe area.




By assuming that $h(t) > h_0$ is preserved (the amount of gas in tank is enough so that both pipe functions without stoppage, deduce the mathematical model of the system and obtain the Laplace transform. Define this plant ($G_p(s)$) in Matlab by using the following parameters (input of the plant is $R_{in}(t)$, output of the plant is $h(t)$):

- ***A*:** Square of sum of numbers in your student ID
  - ID: 21001843 → $A = (\mathbf{2+1+1+8+4+3})^{\mathbf{2}} = \mathbf{361}\ \boldsymbol{m^2}$
- ***a*:** Mean of numbers in your student ID
  - ID: 21001843 → $A = \frac{\mathbf{2+1+0+0+1+8+4+3}}{\mathbf{8}} = \mathbf{2.375}\ \boldsymbol{m^2}$
- $\boldsymbol{h_0}$**:** Height of the second pipe → **5** $\boldsymbol{m}$
- $\boldsymbol{V_0}$: $\boldsymbol{A \times h(0) = A \times 9\ m^3}$

(Initial height of gas is defined as 9 m). Also, you will need to design a controller in the following form, which makes the closed loop system stable (Note that there is a large interval for $K,\ a,\ b$ values, and you can use any of them):

$$G_c(s) = \frac{K(s+a)}{s(s+b)}$$

Draw the Bode plot of $G(s) = G_c(s) \times G_p(s)$ in Matlab (you can use *bode(G)* command in Matlab if you define *G(s)* as tf variable). By using Matlab, draw the Bode plot and find the gain margin, phase margin and delay margin of the system.

You can start with conservation of mass and use the related topic in Chapter-2, and the following equations to obtain the mathematical model (you will need to linearize equations as done in lecture notes):

$$R_{out,1}(t) = a\sqrt{2gh(t)}$$

$$R_{out,2}(t) = a\sqrt{2g(h(t) - h_0)}$$

Note that $g$ is the gravitational acceleration.