Industrial Automation and Robotics

Prof. Rocco

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NAME:

UNIVERSITY ID NUMBER:

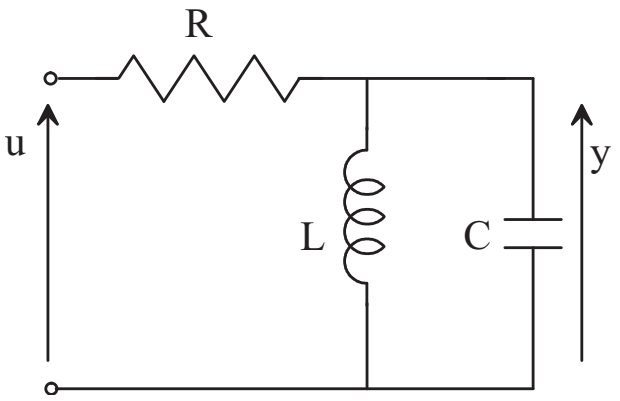
SIGNATURE: _____

Warnings

- This file consists of **8** pages (including cover).
- During the exam you are not allowed to exit the room for any other reason than handing your work or withdrawing from the exam.
- You are not allowed to withdraw from the exam during the first 30 minutes.
- During the exam you are not allowed to consult books or any kind of notes.
- You are not allowed to use calculators with graphic display.
- Solutions and answers can be given **either in English or in Italian**.
- Solutions and answers must be given **exclusively in the reserved space**. Only in the case of corrections, or if the space is not sufficient, use the back of the front cover.
- The clarity and the order of the answers will be considered in the evaluation.
- At the end of the test you have to **hand this file only**. Every other sheet you may hand will not be taken into consideration.

EXERCISE 1

1. Consider the electrical network sketched in the figure:



Write the equations of the dynamic system that describes the electrical network.

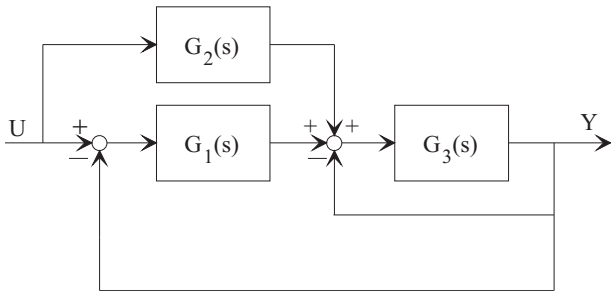
2. Find the equilibrium state and the equilibrium output corresponding to a constant input $u = \bar{u} = 2$

3. Find the expression of the transfer function from the voltage input u to the voltage output y

4. What is the type of the transfer function determined in the previous step?

EXERCISE 2

1. Consider the dynamical system described by the following block diagram:



Solve the block diagram by determining the transfer function from u to y.

2. Discuss whether it is necessary and/or sufficient that one or more of the transfer functions be asymptotically stable in order for the overall system to be asymptotically stable

3. Setting $G_1(s) = 1$, $G_2(s) = 0$, $G_3(s) = \dfrac{1}{s}$ discuss the stability of the overall system

EXERCISE 3

1. Explain what is the difference between the trajectory generation for a robot in the joint space and in the operational space.

2. Consider now the design of a joint trajectory with a trapezoidal velocity profile. The total displacement is $h = 20$, the total positioning time is $T = 1s$ and the acceleration time is $T_a = 0.25s$. Compute the constant speed in the central part of the motion.

3. Compute the value of the acceleration at the beginning of the trajectory

4. Suppose now that the maximum available acceleration is the same found at the previous step, while the maximum available speed is one half of the speed computed previously. For the same displacement of this exercise, find the minimum positioning time.