

Industrial Automation and Robotics

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NAME:

UNIVERSITY ID NUMBER:

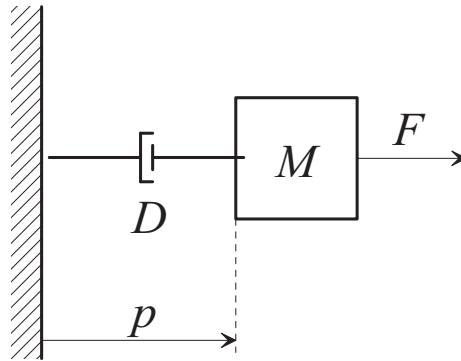
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Warnings

- 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

Consider the mechanical system depicted in the picture:



The system is composed by a body of mass M subjected to a viscous friction force, proportional to the speed through the coefficient D .

1. Write the equations of the system in the time domain.
2. Setting $M = 2$ and $D = 1$, find the transfer function from the force F to the position p .

3. Define the type of a transfer function. What is the type of the transfer function for this exercise?

4. Discuss the stability of the transfer function of this exercise.

EXERCISE 2

1. Explain what is intended with logic control and what is the role of a PLC in an automation system.
2. Consider now an automatic irrigation system. Pressing a button START the automatic irrigation system is activated for one hour. After such time interval, the pump of the irrigation system turns off and for 24 hours pressing the button START cannot activate the irrigation system. Program the system with a Ladder Diagram code.

3. Explain what is the meaning of the following symbol in a Ladder Diagram code:

--|P|--

4. Consider now a digital network with bus architecture: describe the token bus method used to handle the access to the bus among the various agents.

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. Write the expression of a linear path (segment) for planning the position of the end-effector.