

Industrial Automation and Robotics

PROF. ROCCO

JANUARY XX, 2022

NAME:

UNIVERSITY ID NUMBER:

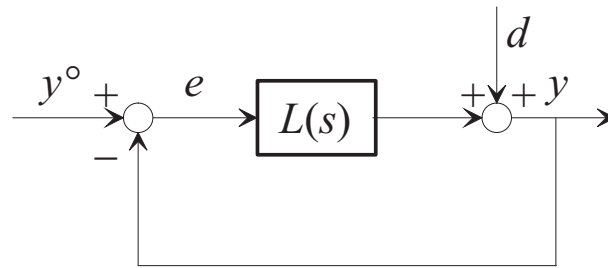
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Warnings

- 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.

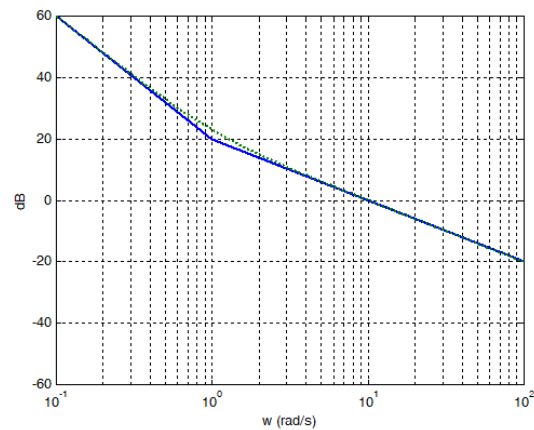
EXERCISE 1

1. With reference to a generic control system



Give the definition of sensitivity function of the system, explaining its use.

2. Suppose that the loop transfer function L has the Bode plot of the magnitude as shown in the figure:



Sketch the asymptotic Bode plot of the magnitude of the sensitivity function.

3. Consider a disturbance $d(t) = \sin(0.3t)$. Compute the factor by which the disturbance is attenuated.

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.

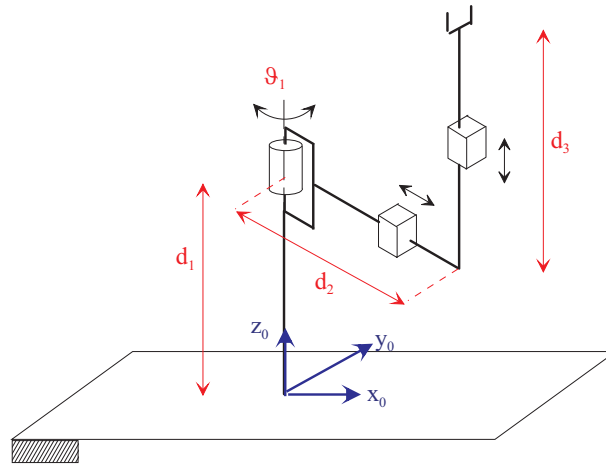
3. Explain what is the meaning of the following symbol in a Ladder Diagram code:

--|P|--

4. Consider now a digital network with bus architecture: describe two possible ways to handle the access to the bus among the various agents.

EXERCISE 3

1. Consider the following robot manipulator with 3 joints (rotational, prismatic and prismatic):



Find the expression of the direct kinematics of the robot, in terms of the position coordinates of the end effector with respect to the joint variables ϑ_1 , d_2 , and d_3 .

2. Write the expression of the Jacobian of this manipulator.

3. Characterize the singularities of this manipulator.