Final Duration: **90** minutes **Spring 2026**

- It is advisable to take knowledge of the entire text before answering any question.

- Applicants must respect the used notation and specify in each case the question number.

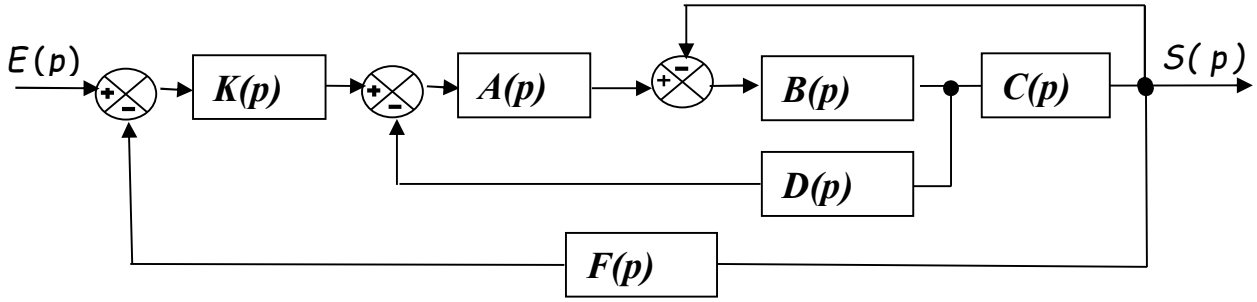
- Most attention will be given to the clarity of writing, presentation, the diagram and the presence of measurement unit

Results will be put in frames - ***Exercises are independent.***

Documentation: An A4 double face is authorized, Calculator authorized, phone forbidden

Exercise 1 (8pts):

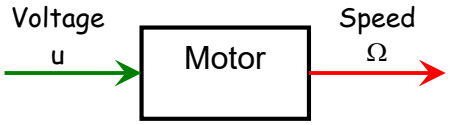
Simplify the following bloc scheme and give its closed loop transfer function H(p)



Give details of calculations or of graphical simplifications (steps).

Exercise 2 (12pts):

Consider a DC permanent magnet motor to be modelled, identified and controlled



The input is the supply voltage u(t) = Unitary step (amplitude 1V) and the output is the motor rotating speed Ω(t). An experimental test gave us the result of Fig. 1.

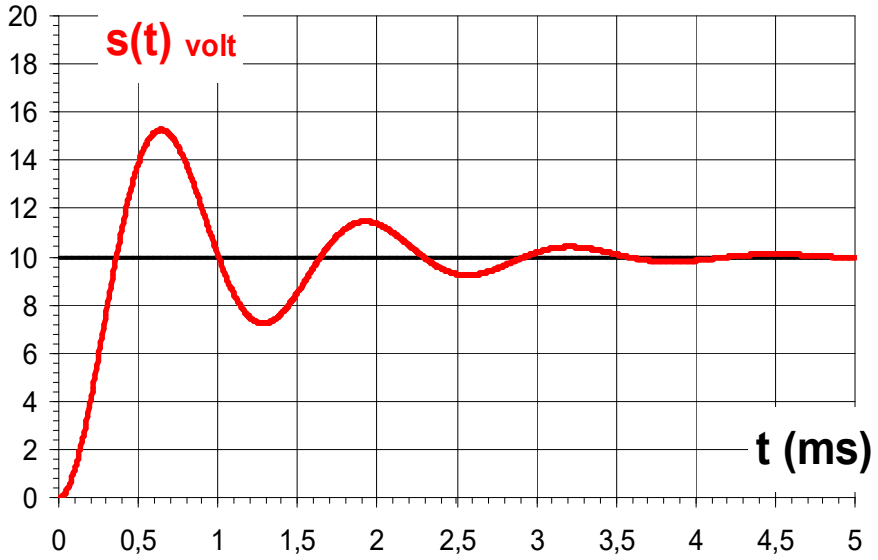


Fig. 1. Experimental Speed data

1) What is the system order? give the transfer function of this order.
2) Using the graph, determine: S_∞ , overshoot D, rise time t_m and the response time at 10% $tr_{10\%}$
3) Deduce, the coefficients of the transfer function.

This system is controlled with an integral controller (gain Ki), and a unitary feedback loop (no sensor).
4) Give the bloc scheme of the motor and the controller
5) Determine the value Ki to have a rise time of 50ms.
6) In the same conditions of question 5), calculate the overshoot. Was this result predictable?
7) Propose an implementation scheme of the controller with analogic component (Amplifiers, …)
8) Calculate the values of the analogic components for this controller

Annexes