Computation exercise 2(a): Actuator

Mechatronic systems
376.050
2016W

Important: Answers must be a hard copy and submitted to the office in CA0421 by December 6, 2016 at 4pm. The work must be original.

Fig. 1 shows a floating mass actuated by a Lorentz actuator, which is driven by a voltage amplifier. The parameter values are given in the following table. Answer the following questions.

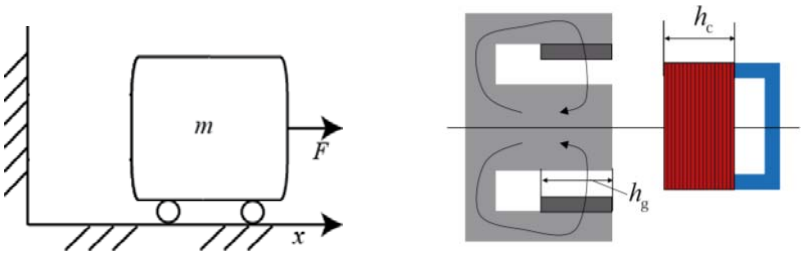

Fig. 1: A lumped mass model of a positioning system, and a schematic of a Lorentz actuator.

Parameter	Value	Unit	Description
m	0.5	kg	Mover mass
n	100	~	Number of windings
d_c	10	mm	Diameter coil
d_w	0.5	mm	Diameter wire
h_c	5	mm	Height coil
B	1.2	T	Magnetic field strength
ρ	$1.7 \cdot 10^{-8}$	$\Omega \cdot m$	Specific resistance
μ_0	$4\pi \cdot 10^{-7}$	NA^{-2}	Permeability in vacuum
μ_r	100	~	Relative permeability
V_{max}	15	V	Amplifier's maximum output voltage

i. Determine the resistance and self-inductance of the coil, as well as the motor constant and the back EMF constant of the actuator. [25%]

ii. Determine the transfer function from the input-voltage to the floating mass position. [25%]

iii. Determine the maximum force of the actuator and the maximum velocity of the floating mass. [25%]

iv. When the number of windings is decreased by half, determine the maximum force and the velocity. By comparing the results with the answers of (iii), discuss the influence of the number of windings on the achievable force and velocity. [25%]