Computation Exercise

- **Successful completion of the computational exercises is a prerequisite for the admission to the final exam.**
- To pass the computation exercises, **a positive result is required for all the following exercises**.
  - Computation exercise 1: Dynamics
  - Computation exercise 2: Actuator
  - Computation exercise 3: Control design

Computation Exercise 1: Dynamics

- For computation exercise 2, two assignments are available:
  - Computation exercise 2(a): System with Lorentz actuator
  - Computation exercise 2(b): System with piezo actuator
- One of the two assignments has to be selected, and its answer must be submitted by the deadline.
- Submission of the exercise
  - Deadline: 17th of December at 4PM (No grace period).
  - Answers must be hard copy with a student name and number.
  - Answers must be submitted to the mail box for Rudolf Saathof in CA0421.
  - Strongly recommended to work alone. (Don't copy)

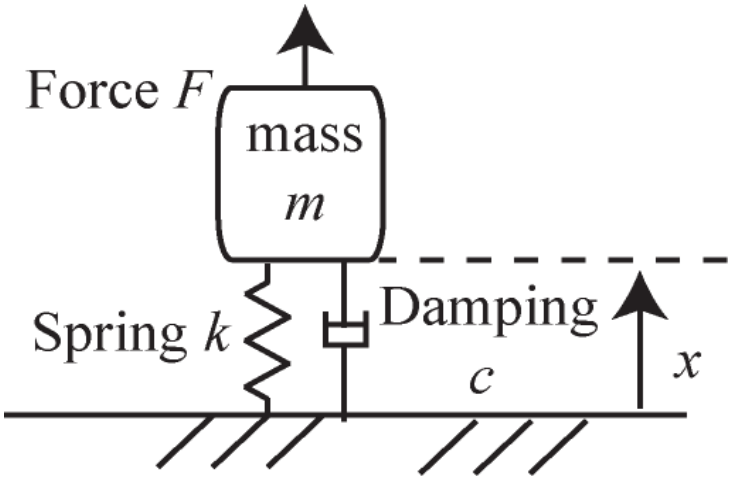
Computation Exercise 1: Dynamics

- It is expected that a software (e.g. MATLAB) is used for the computation exercises.
  - Student licenses are available with a reasonable price at “Zentraler Informatikdienst”.
  - Computers with MATLAB and Maple may be available at the computer laboratory (CA0426). Please talk to Rudolf Saathof after the lecture for reservation.

Computation Exercise 2:

Goal of the exercise:

- Compute amplifier requirements given a:
- Actuator (Lorentz or Piezo)
- Power Spectral Density of the disturbance



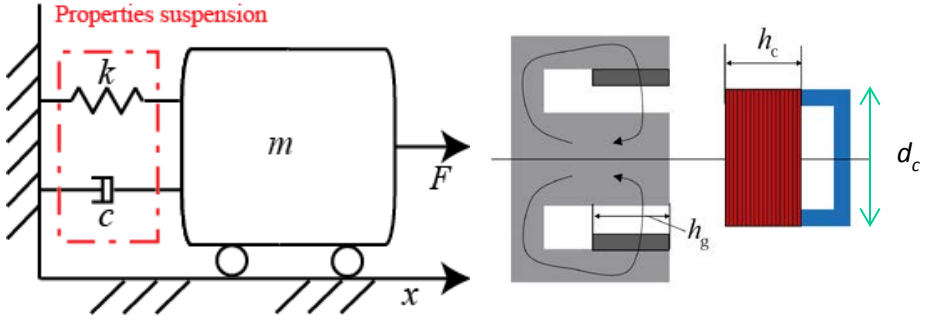
Computation Exercise 2(a): Lorentz Actuator

A disturbance with a power spectral density of 1 μm/$\sqrt{\text{Hz}}$ and a bandwidth of 100 Hz has to be corrected by a Lorentz actuator powered by a current amplifier.

i. Determine the Resistance, self-inductance of the coil and the motor constant of the actuator. [20%]

ii. Determine the transfer function from input-current to displacement x/I and the input-current to voltage [30%]

iii. Determine the required RMS current, voltage and average power [30%]



Parameter	Value	Unit	
m	0.5	kg	Mover mass
k	$30 \cdot 10^3$	N/m	Stiffness
c	1	N/(m/s)	Damping
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	T	Magnetic field strength
ρ	$1.7 \cdot 10^{-8}$	Ω/m	Specific resistance
μ_0	$4\pi \cdot 10^{-7}$	NA^2	Permitivity in vacuum
μ_r	100	~	Relative permitivity

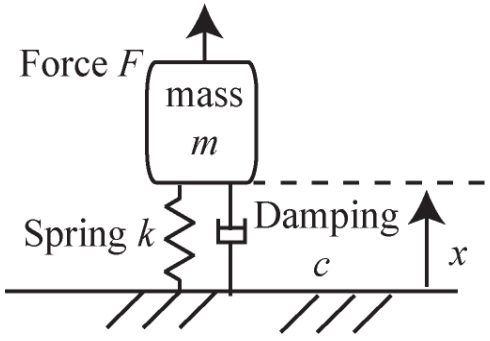
Computation Exercise 2(b): Piezo Actuator

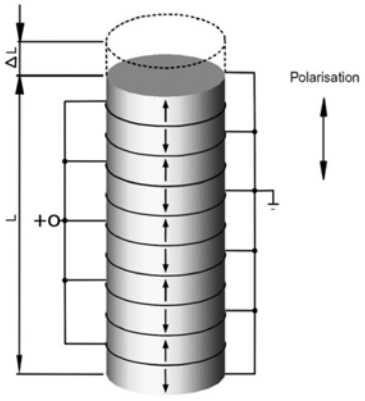
A disturbance with a power spectral density of 1 nm/$\sqrt{\text{Hz}}$ and a bandwidth of 7.5 kHz has to be corrected using a Piezo actuator powered by a voltage amplifier

i. Determine the mass, stiffness and the capacity of the piezo [15%]

ii. Determine the transfer function from input voltage to displacement and the impedance of the piezo amplifier [30%]

iii. Determine the required RMS voltage, current and average power [30%]





Parameter	Value	Unit	
Y	$53 \cdot 10^9$	N/m^2	Youngs modulus
m	10	g	Weight mass
ρ	$7.85 \cdot 10^3$	Kg/m^3	Density piezo
c	10	N/(m/s)	Damping
l_0	25	mm	Length piezo
r	5	mm	Radius piezo
d	$195 \cdot 10^{-12}$	m/V	Piezoelectric coefficient
ε	$1.68 \cdot 10^{-8}$	F/m	Dielectric coefficient
n	170	~	Number of stacks
R	50	Ω	Output impedance