Computation exercise 2(b): Actuator design

Mechatronic systems
376.050
2014W

Important: Answers must be a hard copy and submitted to the office in CA0421 by December 17, 2014 at 4pm. The work must be original.

Fig. 1 shows a lumped mass model of a positioning system using a piezo actuator. The power is provided by a voltage amplifier. The disturbance to be corrected has a power spectral density of 1 nm/$\sqrt{\text{Hz}}$ and a bandwidth of 7.5 kHz. The assignment is to compute amplifier requirements in terms of voltage and current.

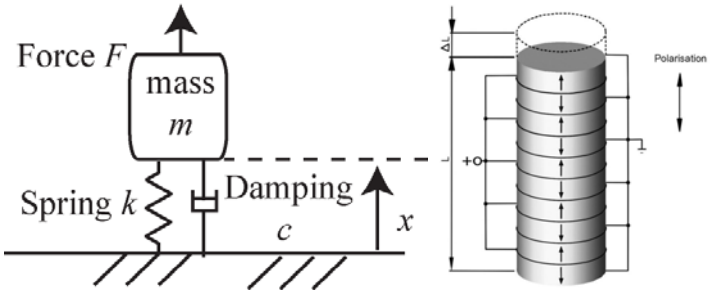

Fig. 1: A lumped mass model of a positioning system and the stacked piezo actuator

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

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 voltage and current [30%]