

# Model Documentation of the Two Mass Floating Bodies

## 1 Nomenclature

### 1.1 Nomenclature for Model Equations

$m_1$	mass of the iron ball
$m_2$	mass of the brass ball
$k_1$	geometry constant
$k_2$	air gap of magnet
$k_f$	spring constant
$g$	acceleration of gravity
$I$	current
$s_1$	position of the iron ball in x-direction
$s_2$	position of the brass ball in x-direction
$v_1$	velocity of the iron ball in x-direction
$v_2$	velocity of the brass ball in x-direction

### 1.2 Graphic of the Structure

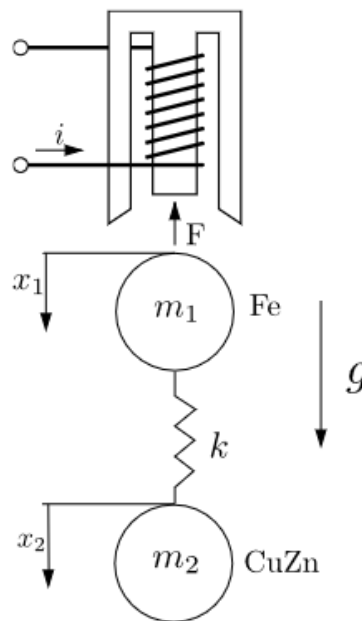


Figure 1: Structure of the Two Mass Floating Bodies Model.  
Source: Wang, Xinyu/Erstellung eines Katalogs regelungstechnischer  
Problemstellungen mit ausführbaren Beispiellösungen

## 2 Model Equations

State Vector and Input Vector:

$$\underline{x} = (x_1 \ x_2 \ x_3 \ x_4)^T = (s_1 \ s_2 \ v_1 \ v_2)^T$$
$$\underline{u} = u_1 = I$$

System Equations:

$$\dot{x}_1 = x_3 \quad (1a)$$

$$\dot{x}_2 = x_4 \quad (1b)$$

$$\dot{x}_3 = g - \frac{k_f}{m_1}(x_1 - x_2) - k_1 \frac{I}{m_1(x_1 + k_2)^2} \quad (1c)$$

$$\dot{x}_4 = g + \frac{k_f}{m_2}(x_1 - x_2) \quad (1d)$$

$$(1e)$$

Parameters:  $m_1, m_2, k_1, k_2, k_f, g$

Outputs:  $s_2$

### 2.1 Assumptions

1. Mass of the iron ball is a pointmass.
2. Mass of the brass ball is a pointmass.

### 2.2 Exemplary parameter values

Parameter Name	Symbol	Value	Unit
mass of the iron ball	$m_1$	0.05	kg
mass of the brass ball	$m_2$	0.04	kg
geometry constant	$k_1$	$4.0 \cdot 10^{-5}$	
air gap of magnet	$k_2$	0.005	m
spring constant	$k_f$	10	$\frac{N}{m}$
acceleration of gravity	$g$	9.8	$\frac{m}{s^2}$

## 3 Derivation and Explanation

The Lagrangian mechanics was used for the solution.

## 4 Simulation

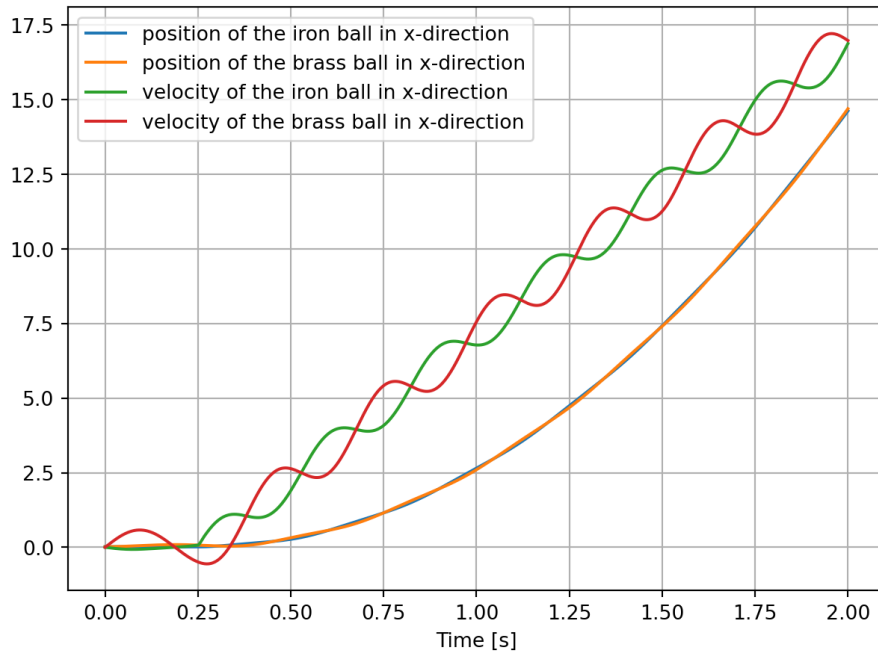


Figure 2: Simulation of the Two Mass Floating Bodies.

## References

- [1] Wang, Xinyu: *Erstellung eines Katalogs regelungstechnischer Problemstellungen mit ausführbaren Beispiellösungen*, student research project at the Institut of Control Theory TU Dresden, 2021.  
(not publicly accessible)