*Group number: Group members:*

**Lab Session 1: Creating a Virtual Model of a Simple Mechanical System**

**Objective**: Develop a virtual model of a pendulum and motor system using Python. Keep in mind that the sample rate of the virtual model should match the sample rate of the sensor’s sample rate (Lab 2).

There are 2 files you need for today. The first and most important is the Digital\_twin.py file. This file is used throughout all the Labs. The second file is Lab\_1\_simulation.py.

* Before getting started watch the following video: <http://tinyurl.com/525buknk>
* Make sure you install all the right python dependencies; you can find them in the requirements.txt file.

Today the goal is to create a model that represents the angular acceleration of the pendulum.  
For the first part you should implement the function below. This function should return the angular acceleration also denoted here as theta\_double\_dot. There is already a function implemented for the model of the motor response in def update\_motor\_accelerations(self, direction, duration). Updating this model such that it is more accurate (better alight with the actual response) can give you bonus points. Ones you have implemented the function get\_theta\_double\_dot(self, theta, theta\_dot) you can run the Lab\_1\_simulation.py. Try to swing up the pendulum using the keys on your keyboard and try to create a sequence of 10 actions that swings up the pendulum.

Afbeelding met tekst, schermopname, Lettertype

Automatisch gegenereerde beschrijving

**Tasks**:

1. **Model the Pendulum**:
   * Include air friction, mechanical friction, length of the pendulum, and gravity in the model.
   * State space parameters should encompass the angle and angular velocity of the pendulum. Try to set the constants such that the behaviour is similar to the real pendulum.
2. **Model the Motor**:
   * Represent the motor in terms of its acceleration effect on the pendulum. (<https://www.mdpi.com/2571-5577/3/2/24>, read this and try to explain how the motor acceleration relates to pendulum model)
   * Ensure the model can simulate the dynamic interaction between the motor and pendulum.