Project 1

First, you must familiarize yourselves with the experimental setup, the safety issues associated with the MARS lab and the lab in general.

Develop the nonlinear dynamic equations of motion for this maglev device in symbolic form – no values will be given for any variables.
Develop an open loop block diagram representation of this system
Develop an open loop block diagram and identify the sensor characteristics. The sensor is a photoresistor. You must run experiments using the provided hardware to identify the sensor transfer function for all the available ferromagnetic objects – 3 balls and a cone.

I. System Modeling

- Develop the non-linear dynamic equations of motion for the system. Define any assumptions.
- Develop an open loop block diagram of the system.
- Develop a Matlab simulation of the system assuming as inputs the quantities that you identify as needed.

II. Linearization

- You need to identify an operating point for linearizing the dynamic equations.
- Develop a Matlab simulation of the system assuming as inputs the quantities that you identify as needed.

III. System Identification

- As part of this project, you will need to identify the various parameters of the maglev system through a series of experiments. These parameters include but not limited (amended as we proceed) the characteristics of the electromagnet, the sensor, etc.
- You will accomplish this task by collecting a set of experimental measurements. For example, if you would like to find the electromagnetic force you will need to plot the current and the distance from the electromagnet of objects of known weight and then plot it or perform some statistical analysis on it.

- **Addendum**
  Using various objects of known mass, identify the characteristics of the electromagnetic coil by measuring the sensor output and the current through the coil. The sensor output will provide the operating point. The current is related to the generated electromagnetic force. Perform the experiments using the various objects in the lab. The mass of the objects is written on them.
  NOTE: The first object below the electromagnet (the object between the sensor emitter receiver pair) must be one of the two large ball bearings. These are the ball bearings used for identifying the sensor.

IV. Experiment with the analog controller

- Experiment with the analog controller and describe the performance of the system by levitating various objects of known mass.
- What do you think are the main reasons for the system behaving or non-behaving in a stable fashion?

Useful Formula: Electromagnetic Force, $$f(x,i) = k_f \left(\frac{i}{x} \right)^2$$

i is the current to the electromagnet
x is the distance between the electromagnet and the levitated object
k_f is the proportionality constant

Model the electromagnetic coil as a resistor and inductor in series.