Lab 3: MDOF Systems

Instructions:

- **Lab reports must be typed.**
- Prepare and submit your lab report as a single PDF file through eClass.
- Include an Excel file containing your data with your submission.
- Required plots can be made with any software of your choice (MATLAB, Excel, Mathematica, etc.).
- While you can discuss the problems with classmates, all submitted work must be your own to conform to academic integrity guidelines.
- **Late submissions will not be accepted.**

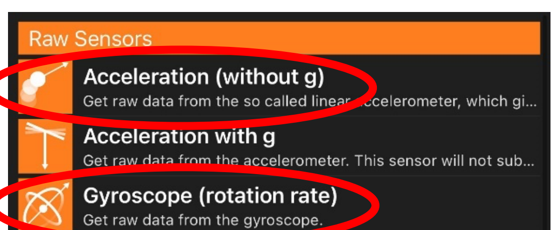
Preface

The objective of this lab is to understand and provide a hands-on experience with a MDOF system with coupled coordinates.

For this lab, you will be recording data using the built-in accelerometer on your phone. Before coming to the lab, please download the PhyPhox application on your phone. It is available for free and compatible with Android and iOS phones.

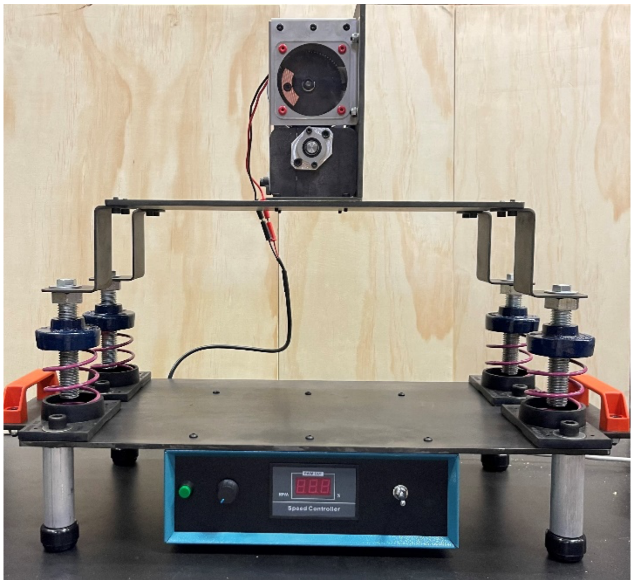
In this lab, you will be recording:

- Translational acceleration data using the "Acceleration (without g)" function
- Angular velocity data using the "Gyroscope (rotation rate)" function

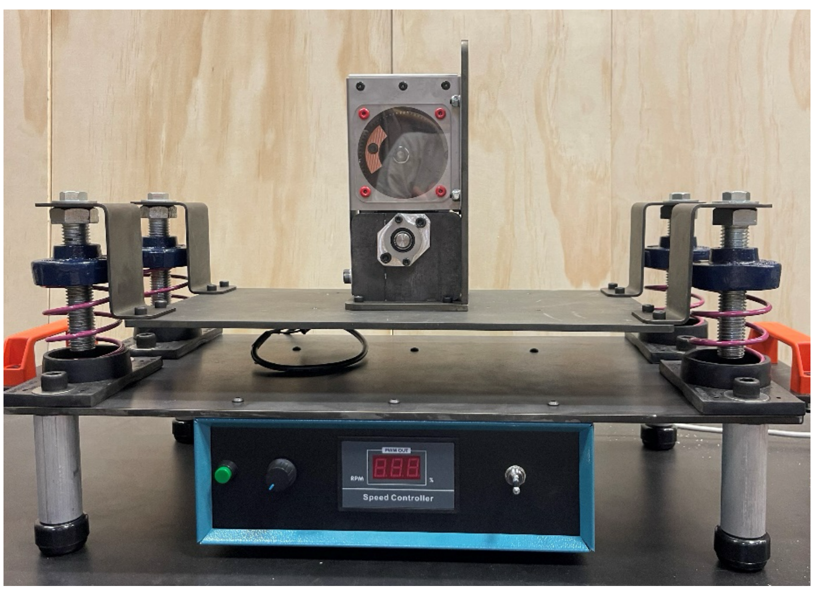


Instructions

In this lab, you will measure the dynamic behaviour of the apparatus in two configurations:



Configuration A



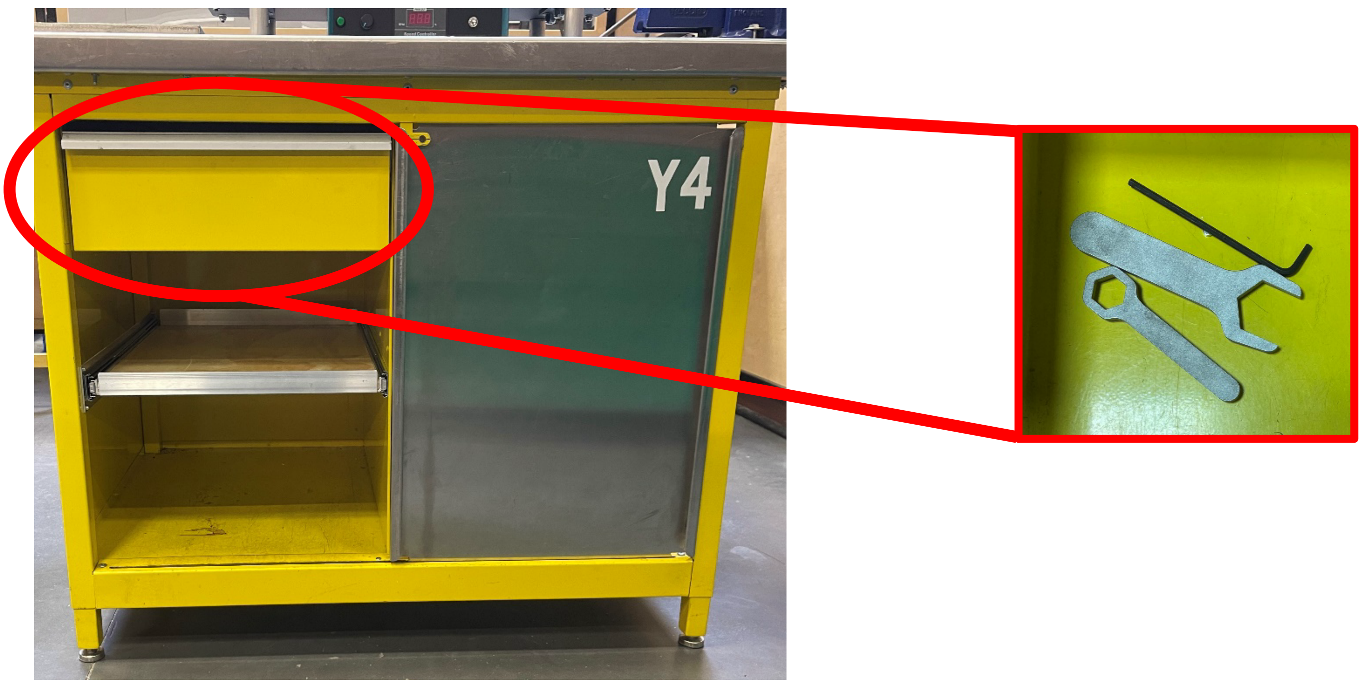
Configuration B

<u>Note:</u> The power switch and on-button serve the same purpose. Use the power switch to turn the motor on and off. Although "RPM" is indicated on the controller, the number corresponds to the power output to the motor as a percentage of its maximum power output. As a result, you will have to calculate the frequency manually using the time interval between adjacent peaks.

The platform should already be in Configuration A when you start this lab.

1. Ensure that the power is plugged in and that there are no loose parts on the platform before turning on the motor.

2. The drawer in your workbench should contain two wrenches and an Allen key as shown. You will need these later.



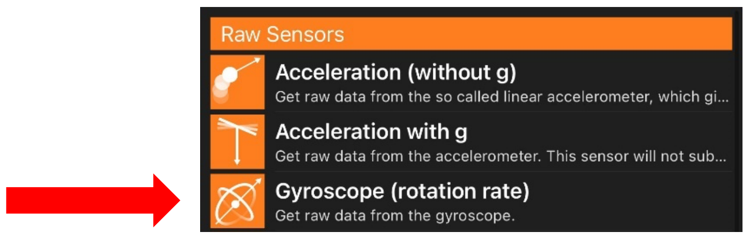
3. Turn on the motor and incrementally increase the motor speed until you locate the first point of resonance. This should occur around 9 – 11% as indicated by the controller. Make a note of the general mode shape and the relative location of the nodal point.

4. Place your phone on the platform and open the PhyPhox app. Select the "Acceleration (without g)" option.

5. Turn the motor on and wait for a couple of seconds to allow any transient effects to dissipate. These effects are generally associated with the motor as it reaches the speed as indicated by the controller.

6. Press the “Start” button to initiate data collection for a few cycles. Afterwards, export your data as an Excel file. Ensure that you record the configuration (A), mode number (1), and type of motion (translational acceleration).

7. While the motor is running at the same speed, record the angular acceleration of the platform using the “gyroscope (rotation rate)” function on PhyPhox. Record data for a few cycles, then export your data as an Excel file. Ensure that you record the configuration (A), mode number (1), and type of motion (angular velocity).



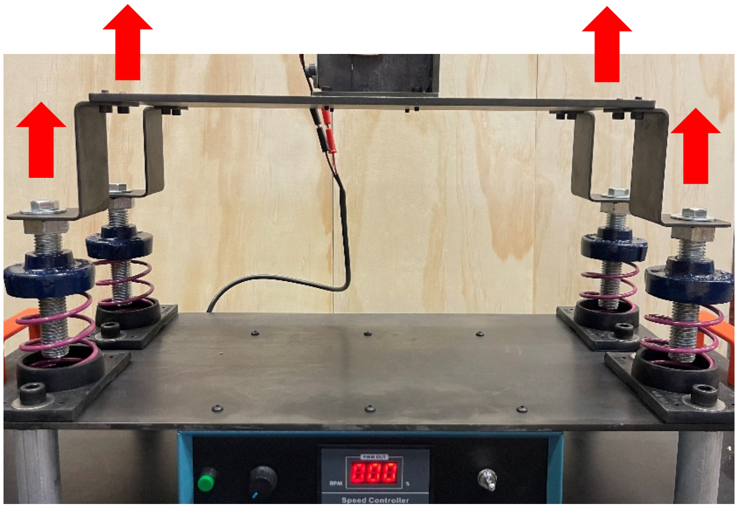
8. Incrementally increase the motor speed until you locate the second point of resonance. This should occur around 18 – 20% as indicated by the controller. Make a note of the general mode shape and the relative location of the nodal point.

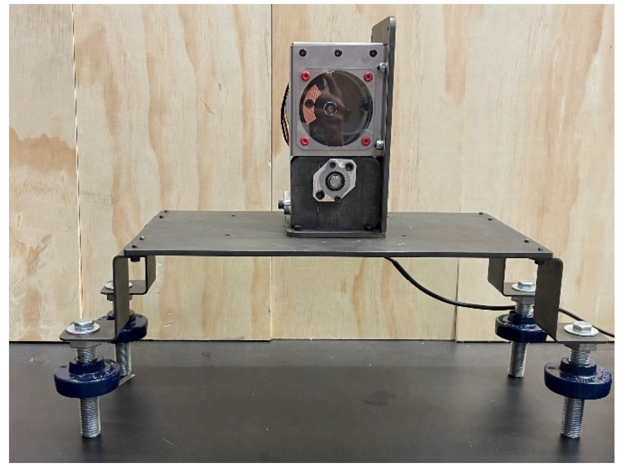
9. Repeat Steps 4 – 7, so that you have collected both the translational acceleration using the “Acceleration (without g)” option and the angular velocity using the “Gyroscope (rotation rate)” option. Ensure that you record the configuration (A), mode number (2), and type of motion (translational acceleration or angular velocity).

10. Remove your phone from the platform.

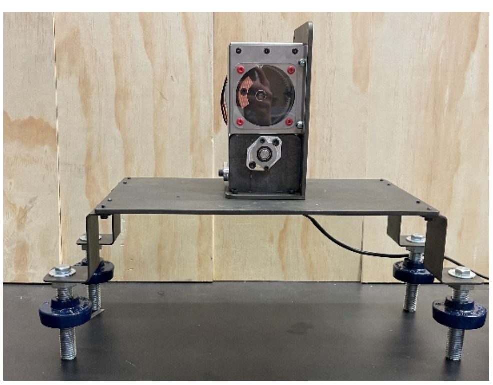
The second half of this lab will involve repeating the data collection for the platform when it is in Configuration B.

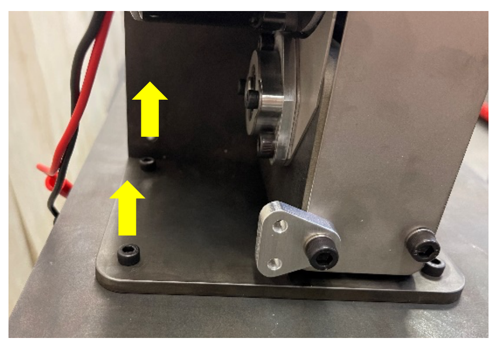
11. Carefully dismount the platform from the springs by lifting the platform up. The springs should detach with little resistance as shown in the picture.

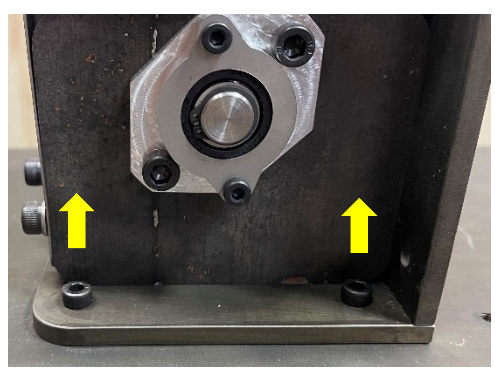




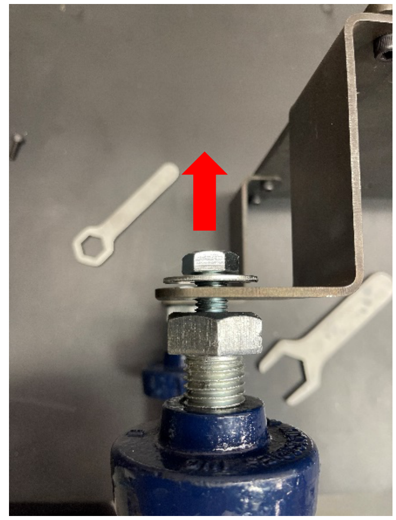
12. Remove the motor assembly by loosening the four bolts as indicated below.



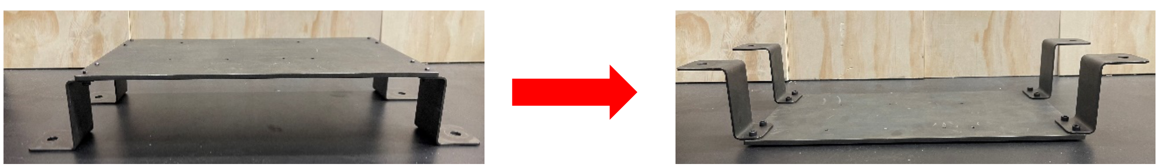




13. Remove the spring mount components using the two wrenches located in the drawer of your workbench.

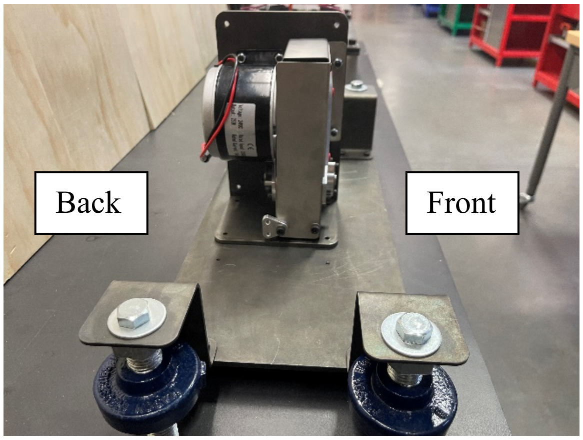



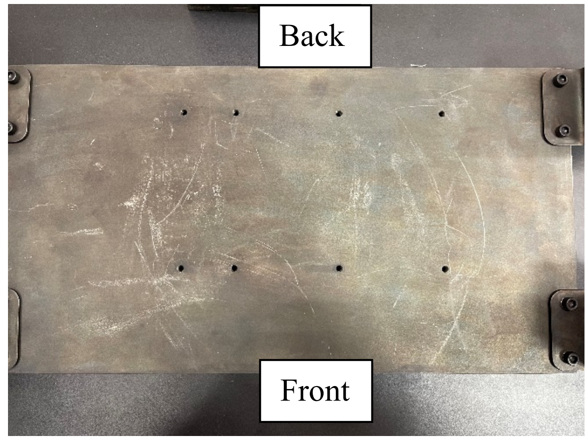
14. After all spring mounts have been removed, flip over the platform so that the brackets are now raised above the platform surface.



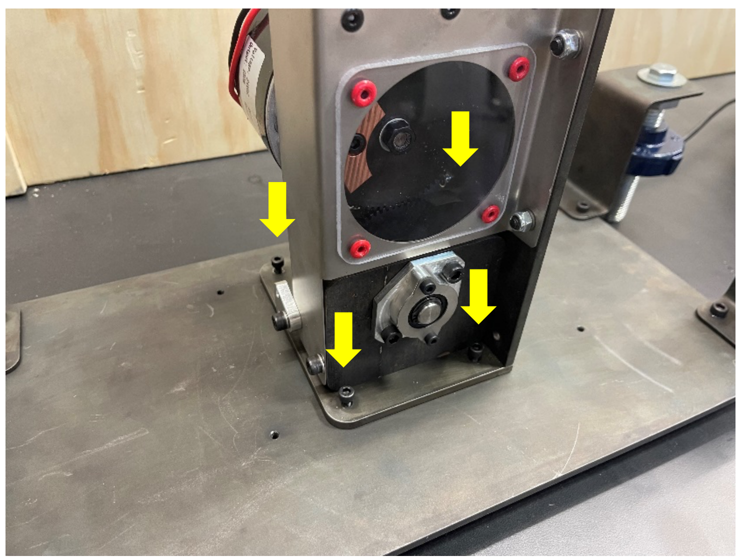
15. Re-install the spring mounts so that the platform is now in a lowered position as shown below.

16. Remount the motor assembly onto the platform. **Check that the motor is properly positioned on the platform – the gears should be positioned at approximately the centre of the platform and should be as shown below.**



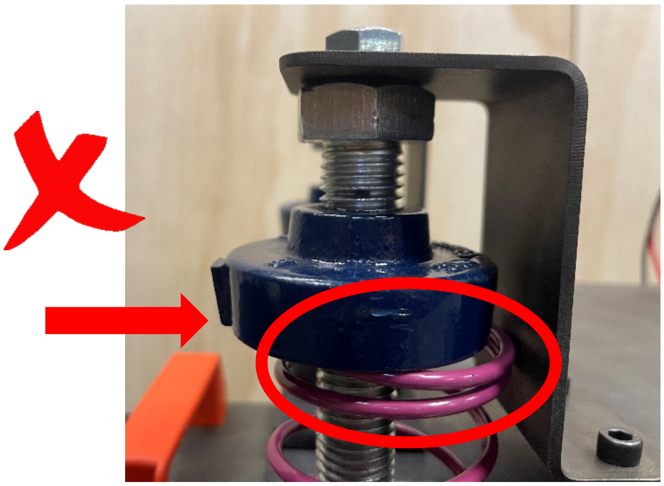


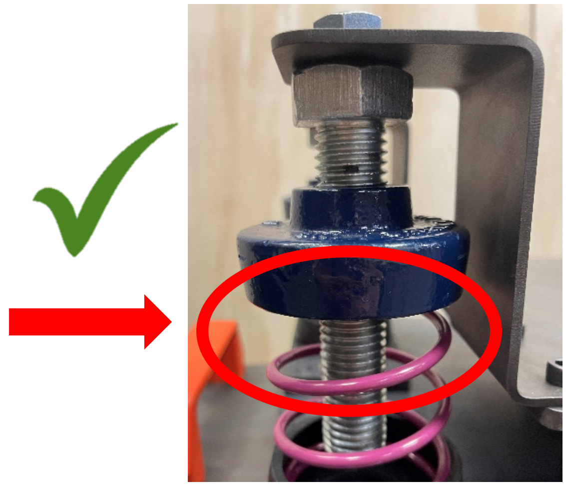
Re-install four bolts



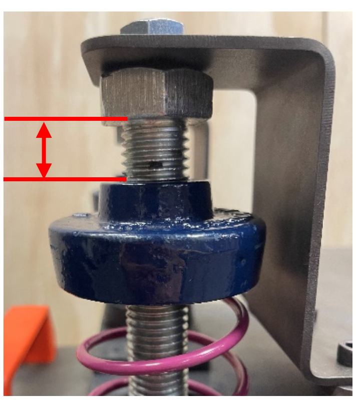
17. Remount the platform onto the springs.

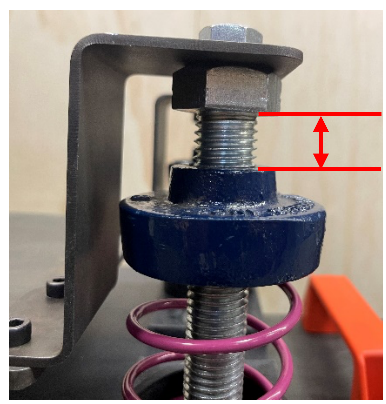
a. **Ensure that the springs are properly seated in the connection piece.**





b. **Ensure that the height of each spring is approximately the same. You can do this by counting the number of threads between the bolt head and the blue metal spring mount. Rotate the blue metal piece to adjust the spring height.**





18. For Configuration B:

a) **<u>For the first point of resonance (around 11%):</u>**

- Collect the acceleration time data using the “Acceleration (without g)” function on PhyPhox. Ensure that you record the configuration (B) and point of resonance (1).

b) **<u>For the second point of resonance (around 19%):</u>**

- Collect the angular velocity time data using the “Gyroscope (rotation rate)” function on PhyPhox. Ensure that you record the configuration (B) and point of resonance (2).

At the end of this lab, you should have the following sets of data:

<u>For Configuration A:</u>

1) The translational acceleration vs. time for the first point of resonance.
2) The angular velocity vs. time for the first point of resonance.
3) The translational acceleration vs. time for the second point of resonance.
4) The angular velocity vs. time for the second point of resonance.

5) Visual note of the platform’s motion and node locations for the first point of resonance.
6) Visual note of the platform’s motion and node locations for the second point of resonance.

<u>For Configuration B:</u>

1) The translational acceleration vs. time for the first point of resonance.
2) The angular velocity vs. time for the second point of resonance.