Modular Vibration Testing Kit for Vibrations Lab Courses

Team Members
Michael Ahlers, Seth Madison
Tyler Motzko

Project Advisors
Dr. Ahsan Mian, Dr. Craig Baudendistel
Dr. Abdalsalam Fadeel II

Theory
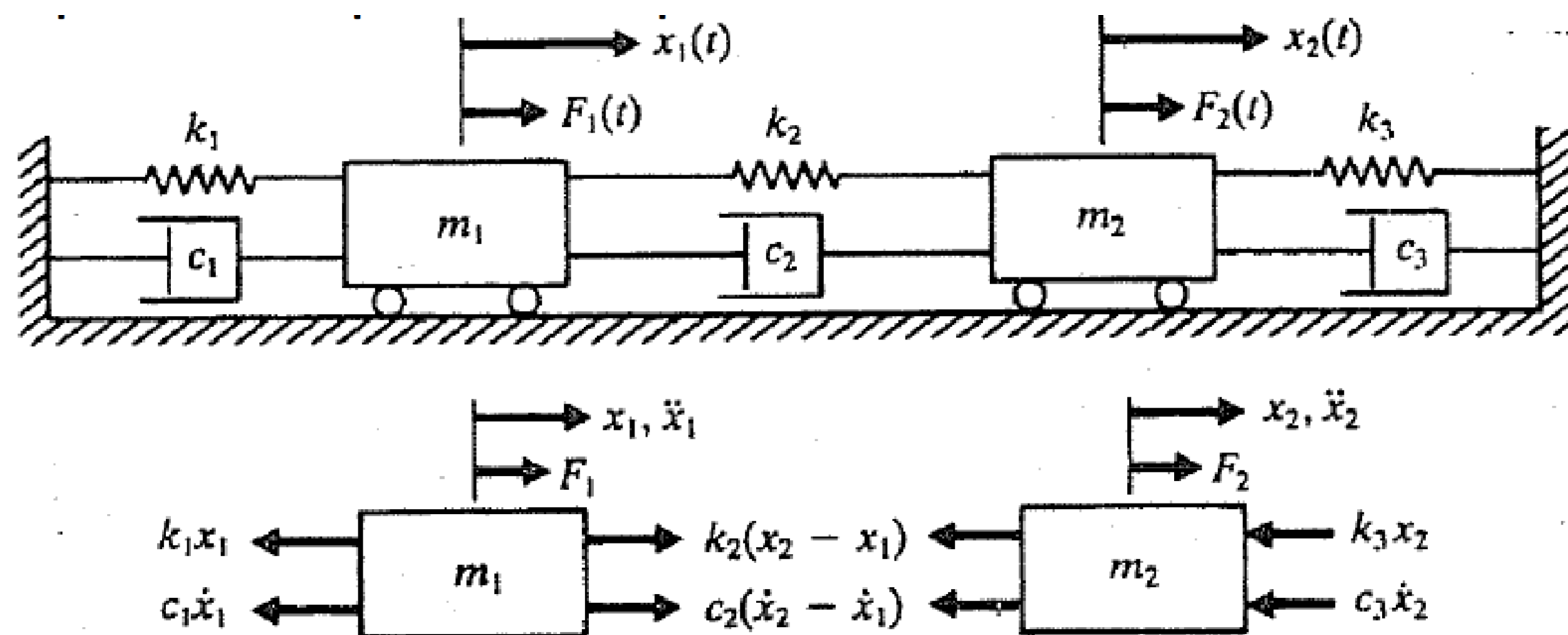
### Equations of Motion for a Two Degree of Freedom Spring Mass System

$$\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix}\begin{bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{bmatrix} + \begin{bmatrix} c_1 + c_2 & -c_2 \\ -c_2 & c_2 + c_3 \end{bmatrix}\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} + \begin{bmatrix} k_1 + k_2 & -k_2 \\ -k_2 & k_2 + k_3 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} F_1 \\ F_2 \end{bmatrix}$$

Development of Lab Experiments
- Single Degree of Freedom Free Vibration
- Single Degree of Freedom Forced Vibration
- Two Degrees of Freedom Free Vibration
- Two Degrees of Freedom Forced Vibration

3D Printing
- Very low cost, less than $25 of filament used
- One day printing time for **all** parts
- One full set uses approx. **278 grams** of filament
- Complete control over overall design
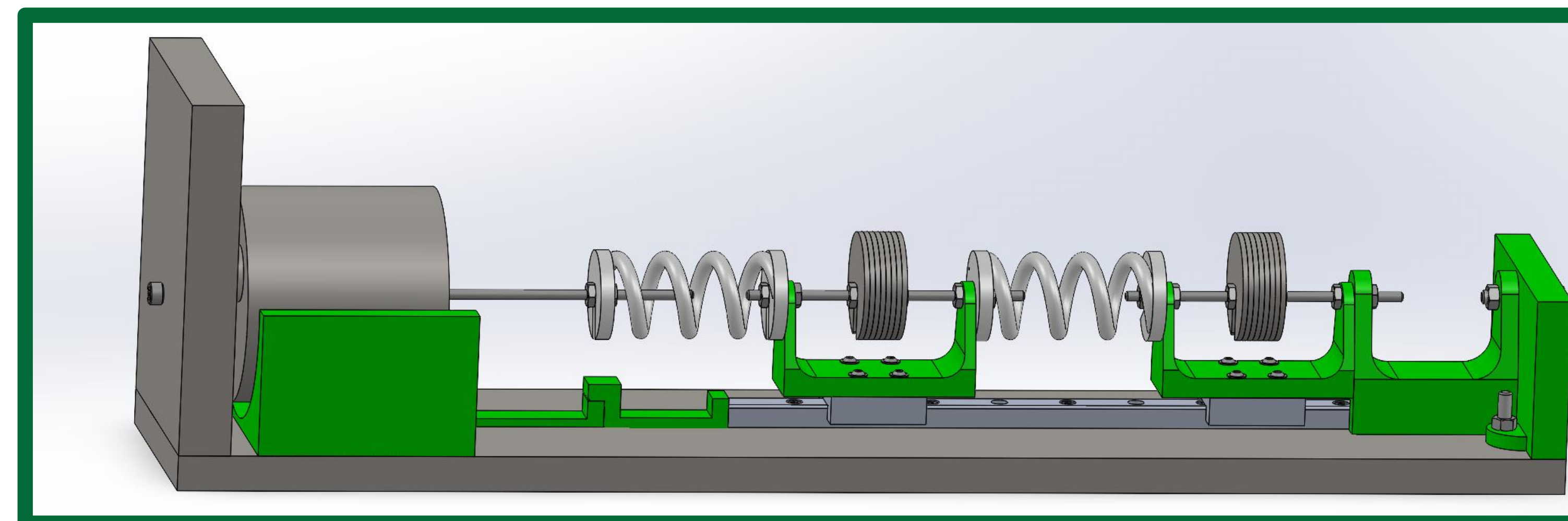- Spring properties determined by printing settings and material used (PLA, PETG, ABS, TPU etc.)
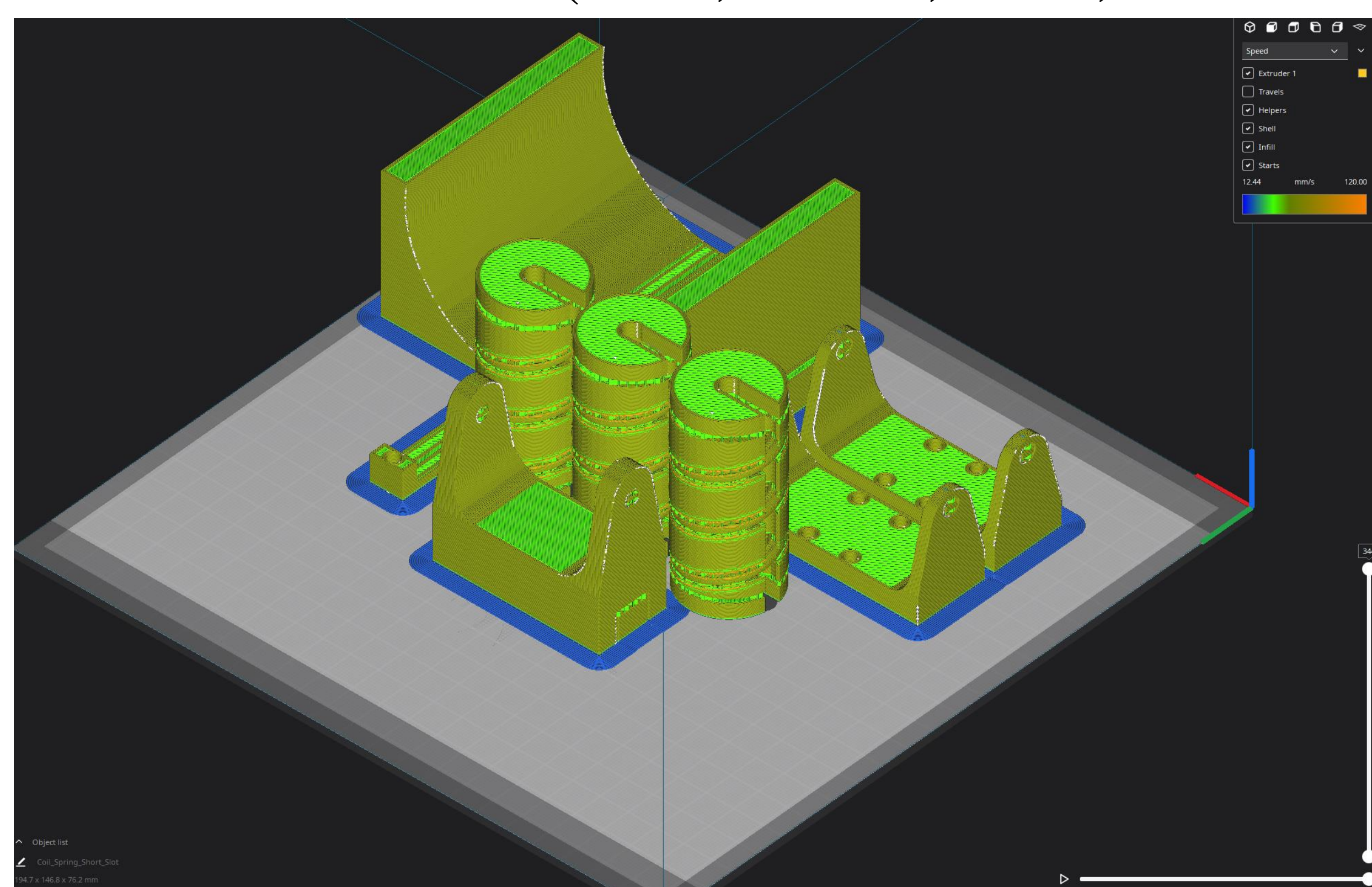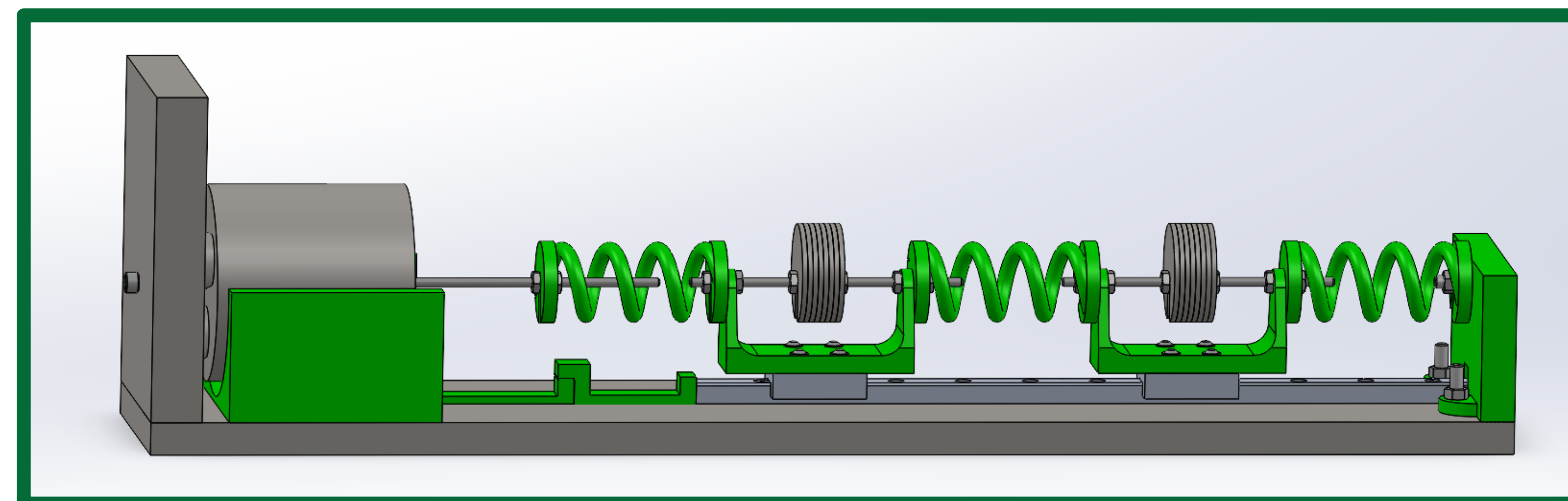

Project Objective
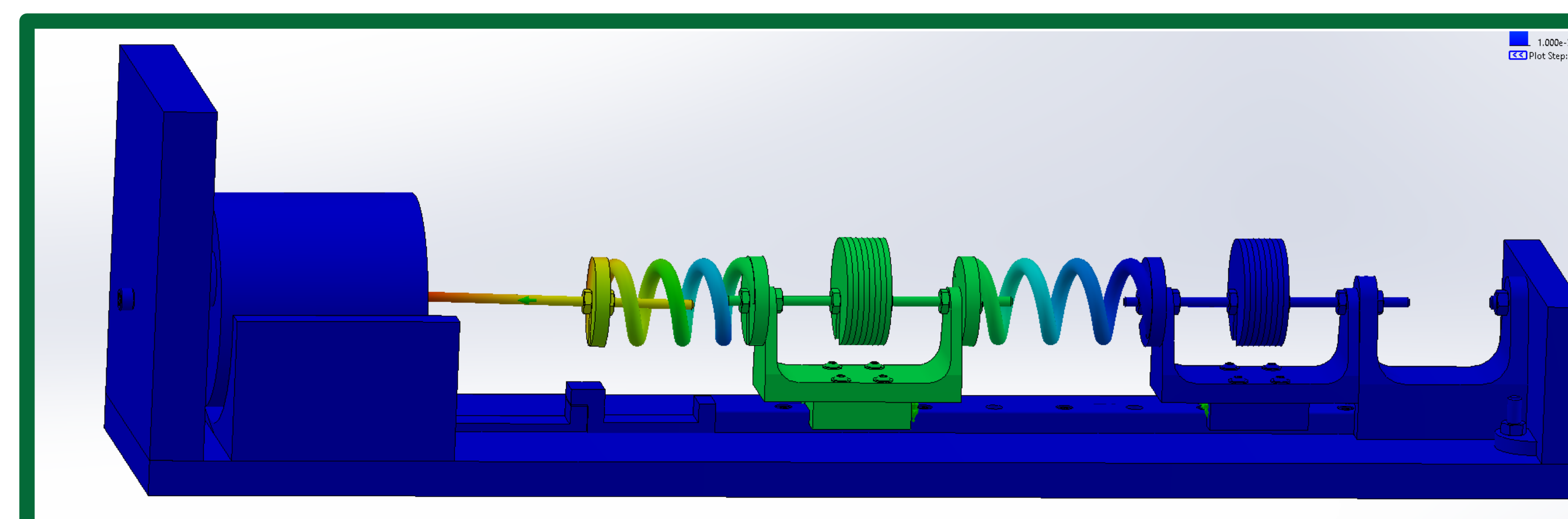Design a tabletop vibration testing platform that can be used in a vibration lab experiment.
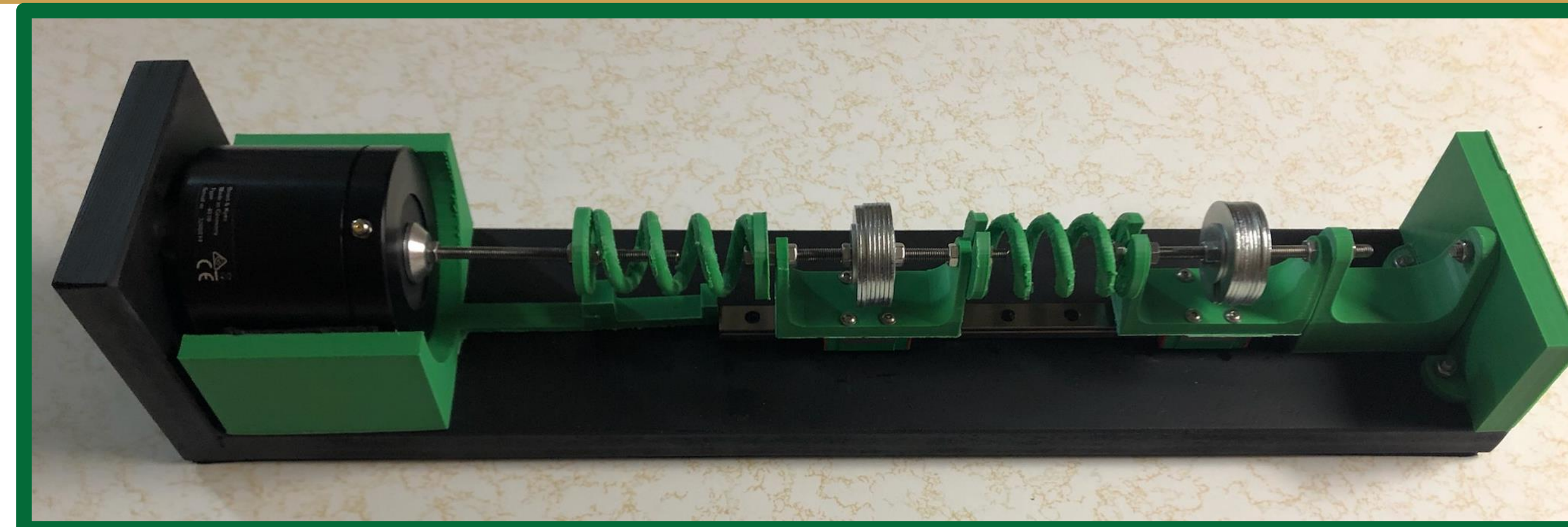
One Degree Of Freedom Assembly

One Degree Of Freedom Assembly

Linear Dynamic: Modal Time History Analysis
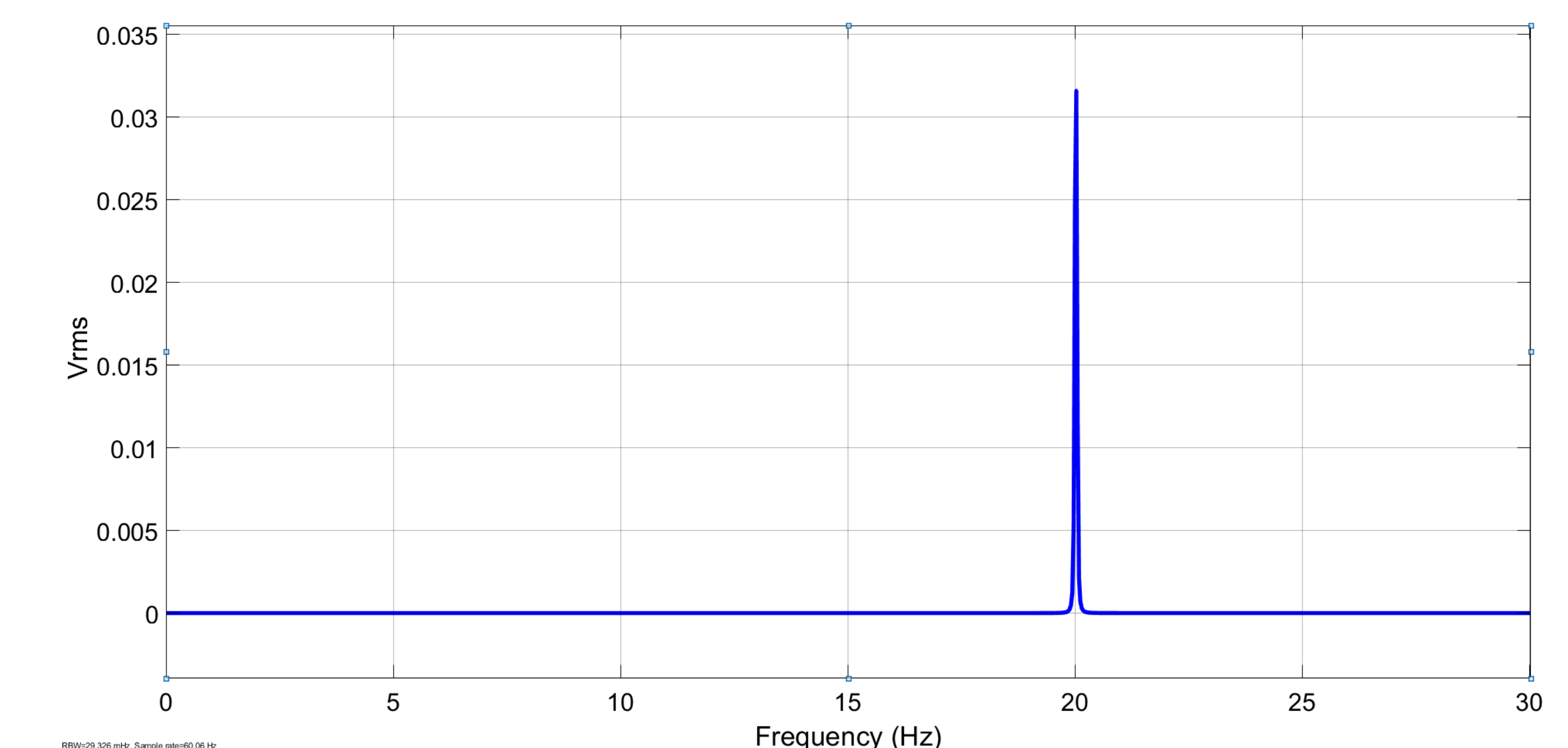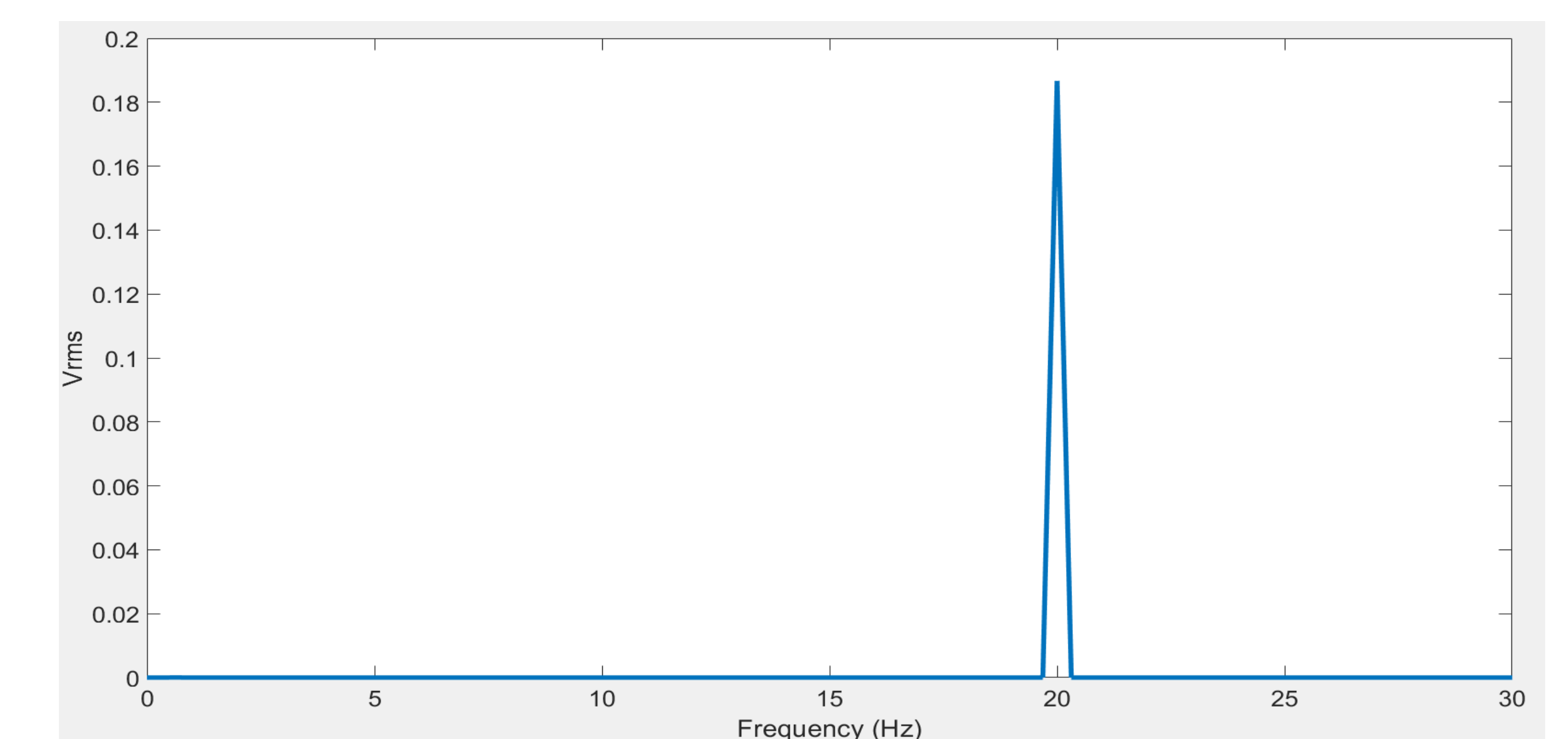URES: Resultant Displacement

Results

Theoretical Calculation for Natural Frequency

$$f_n = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = 20.02\ Hz$$

Simulink Prediction for Natural Frequency

Experimentally Measured Natural Frequency

Wright State College of Engineering and Computer Science

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