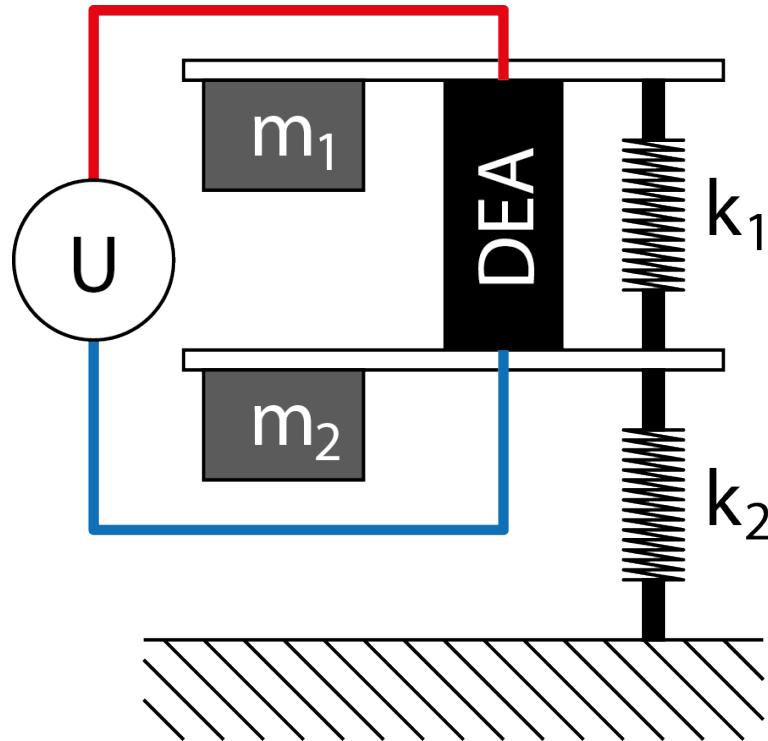




Design and Simulation of a Vibratory System Driven by DE Membrane Actuators

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task 1 - the Testing Assembly



- vibratory actuator
- 2-degrees of freedom
- DE strip actuator



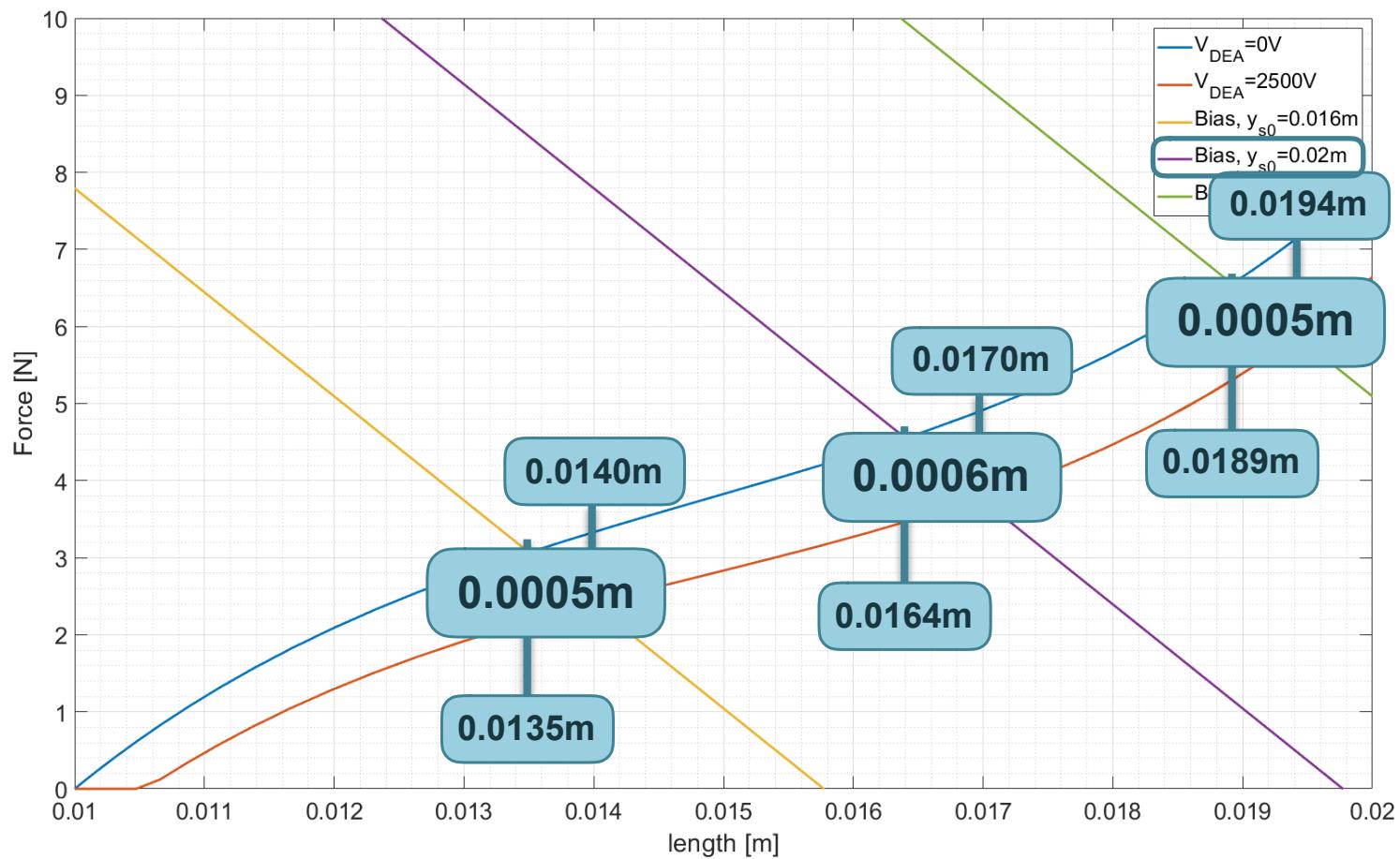
Given System:

$$\begin{cases} F_e - m_1g - k_1(y_1 - y_2 - y_{s0}) - NF_{DE}(l, v) &= m_1\ddot{y}_1 \\ -m_2g + k_1(y_1 - y_2 - y_{s0}) + NF_{DE}(l, v) - k_2y_2 &= m_2\ddot{y}_2 \\ l_1 &= y_1 - y_2 \end{cases}, F_e = 0$$

Therefore:

$$y_2 = \frac{-g \cdot (m_1 + m_2)}{k_2}$$

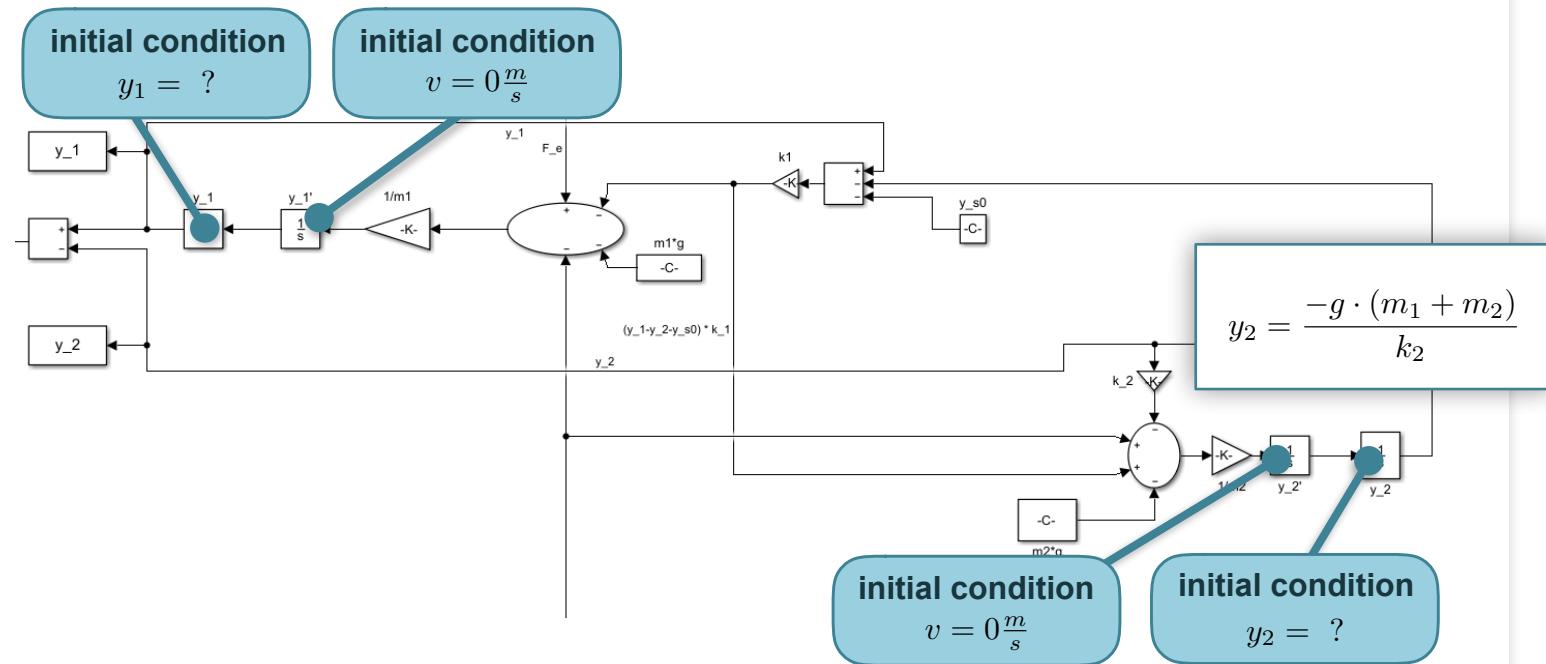
$$F_{DE} = F_{Bias} = \frac{-g \cdot m_1 - k_1 \cdot (l_1 - y_{s0})}{N}$$



Force-Length plot of different springs against DEA



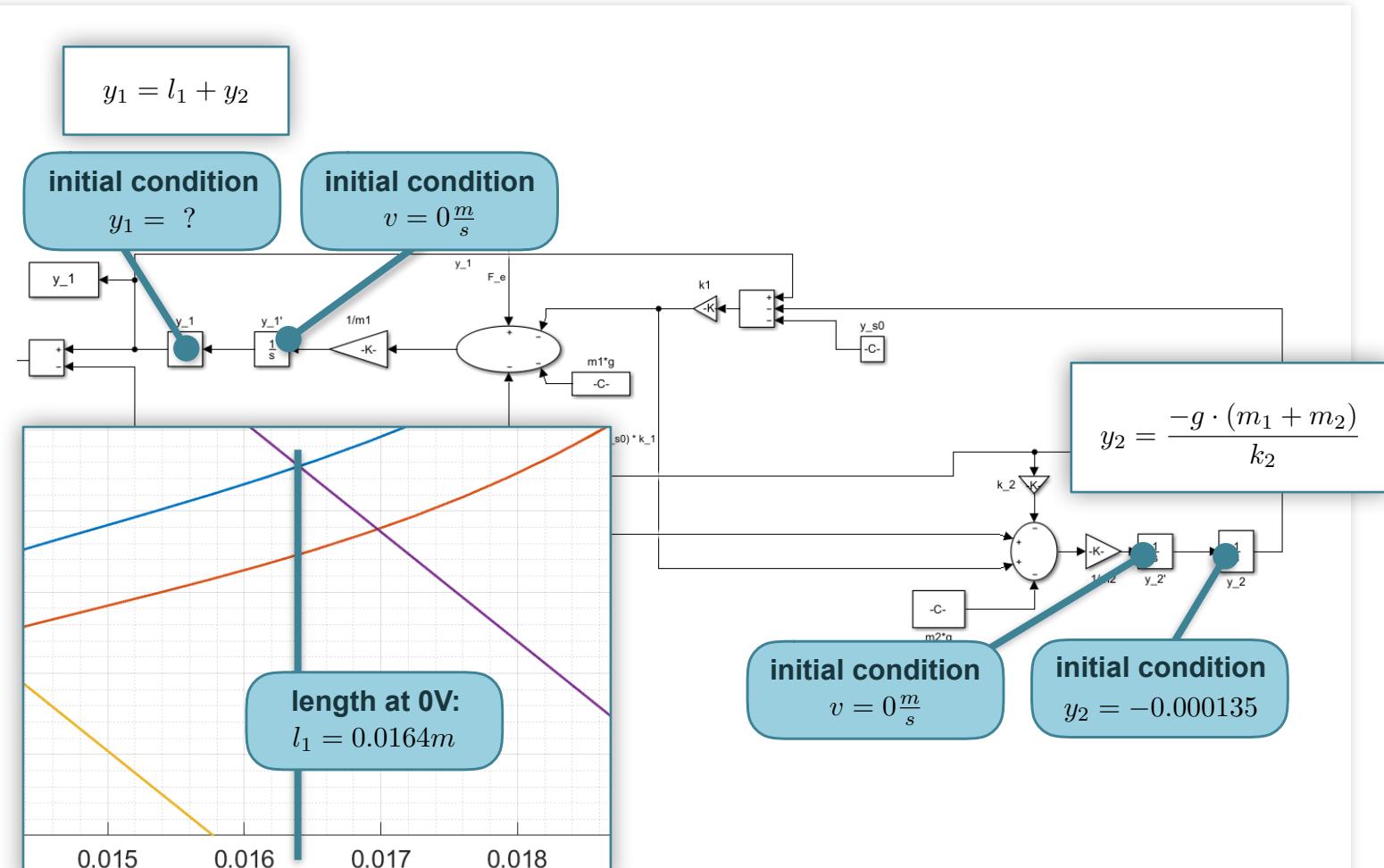
task 2 - set Initial Conditions



Simulink block diagram of the system

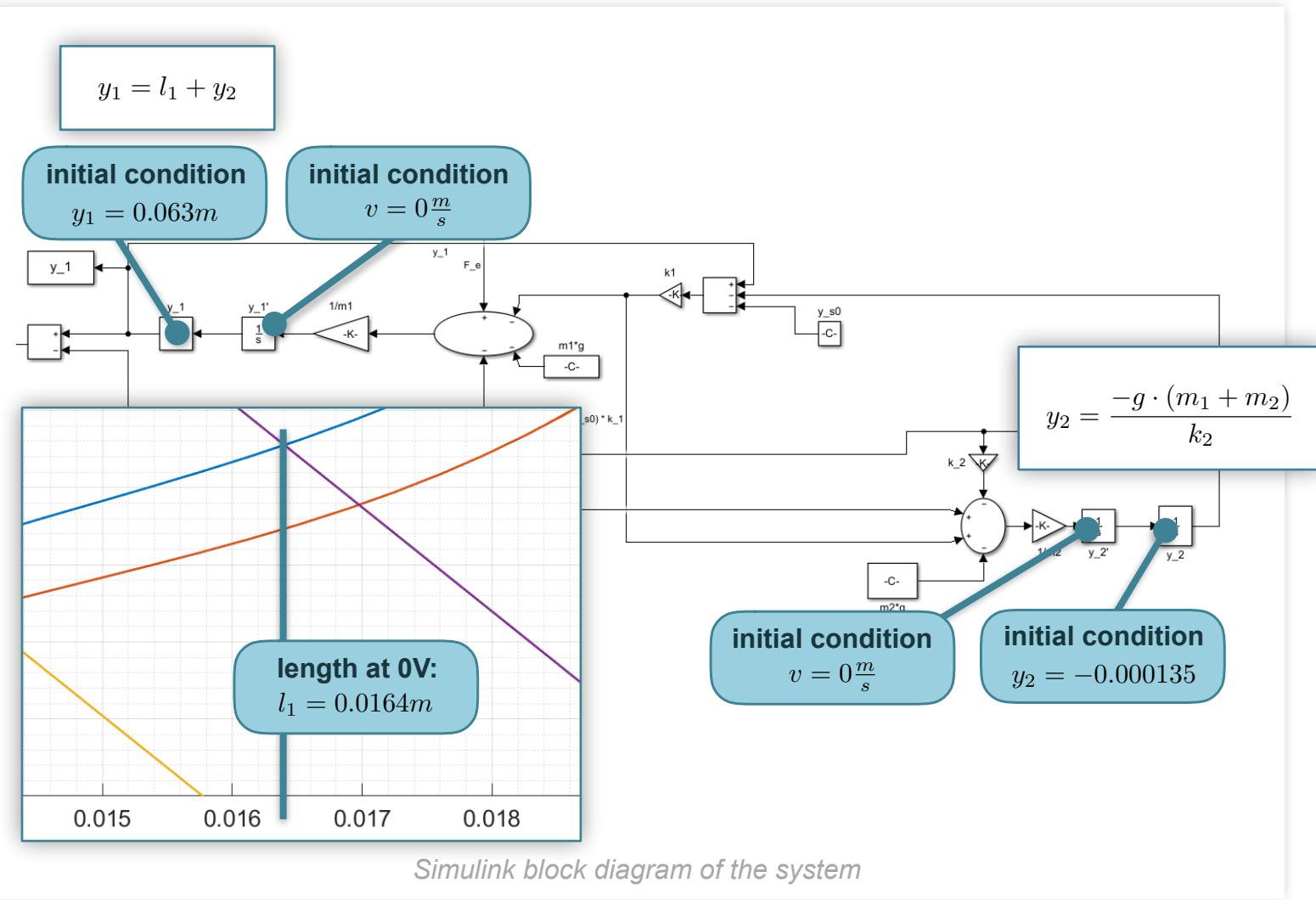


task 2 - set Initial Conditions

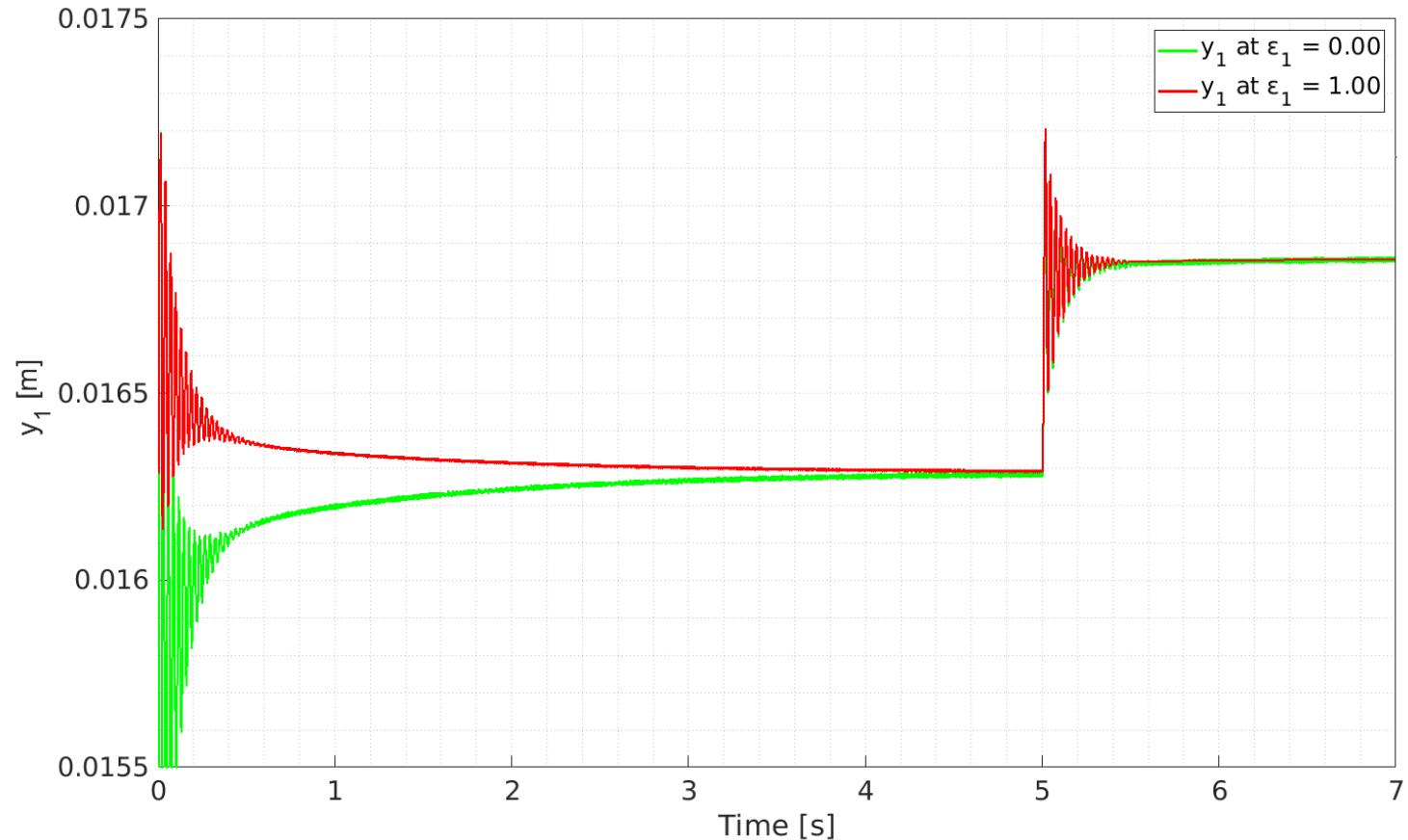




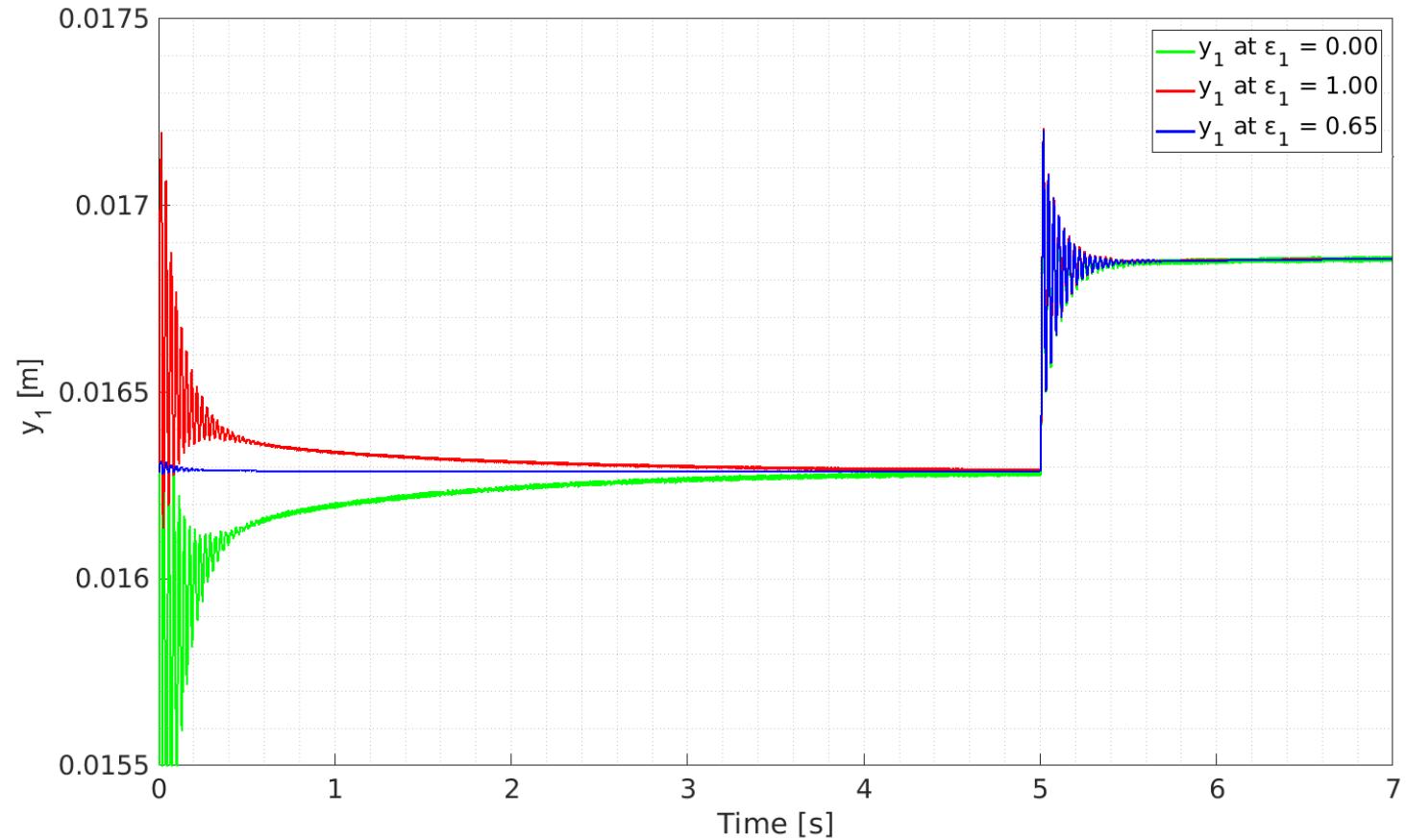
task 2 - set Initial Conditions



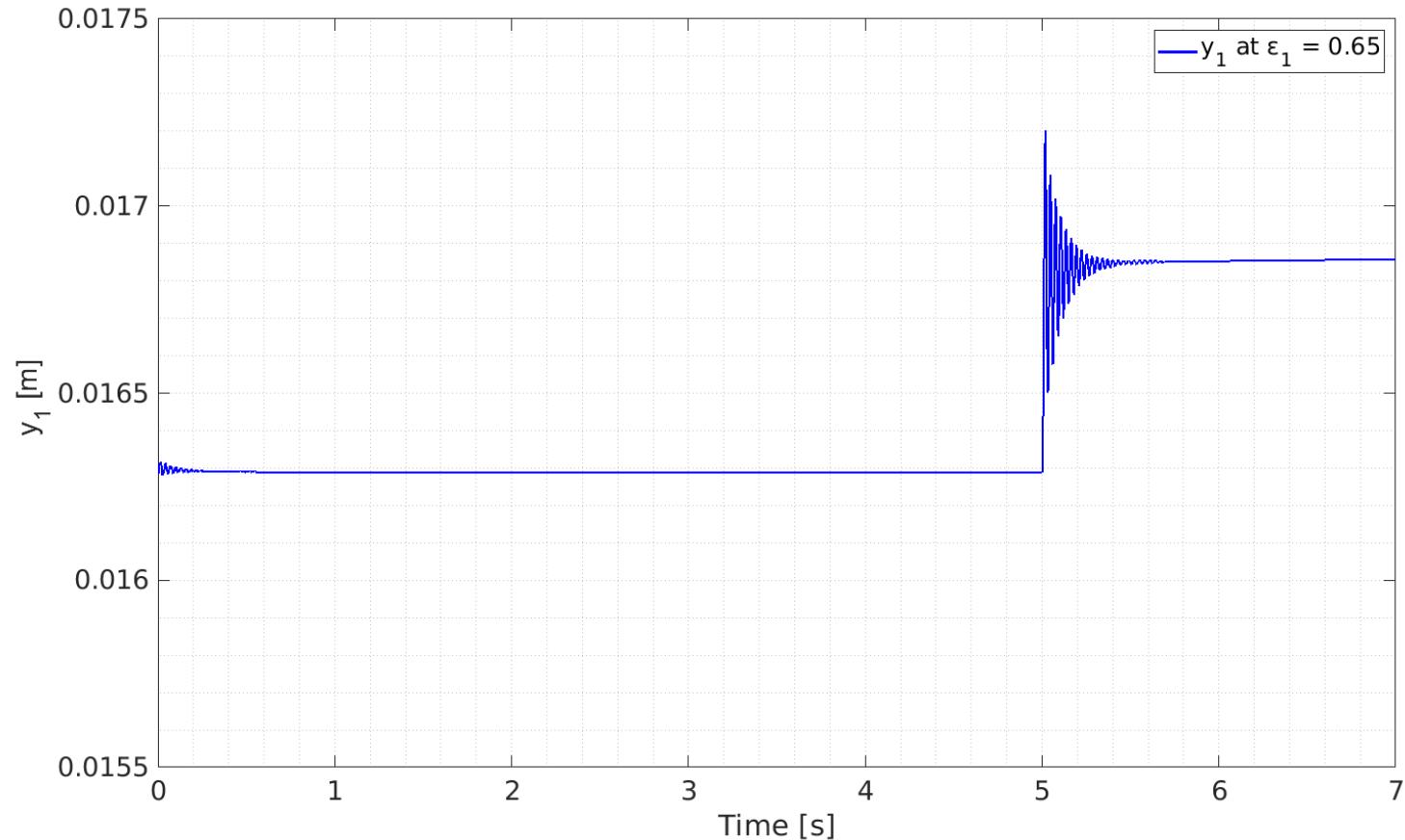
Simulink block diagram of the system



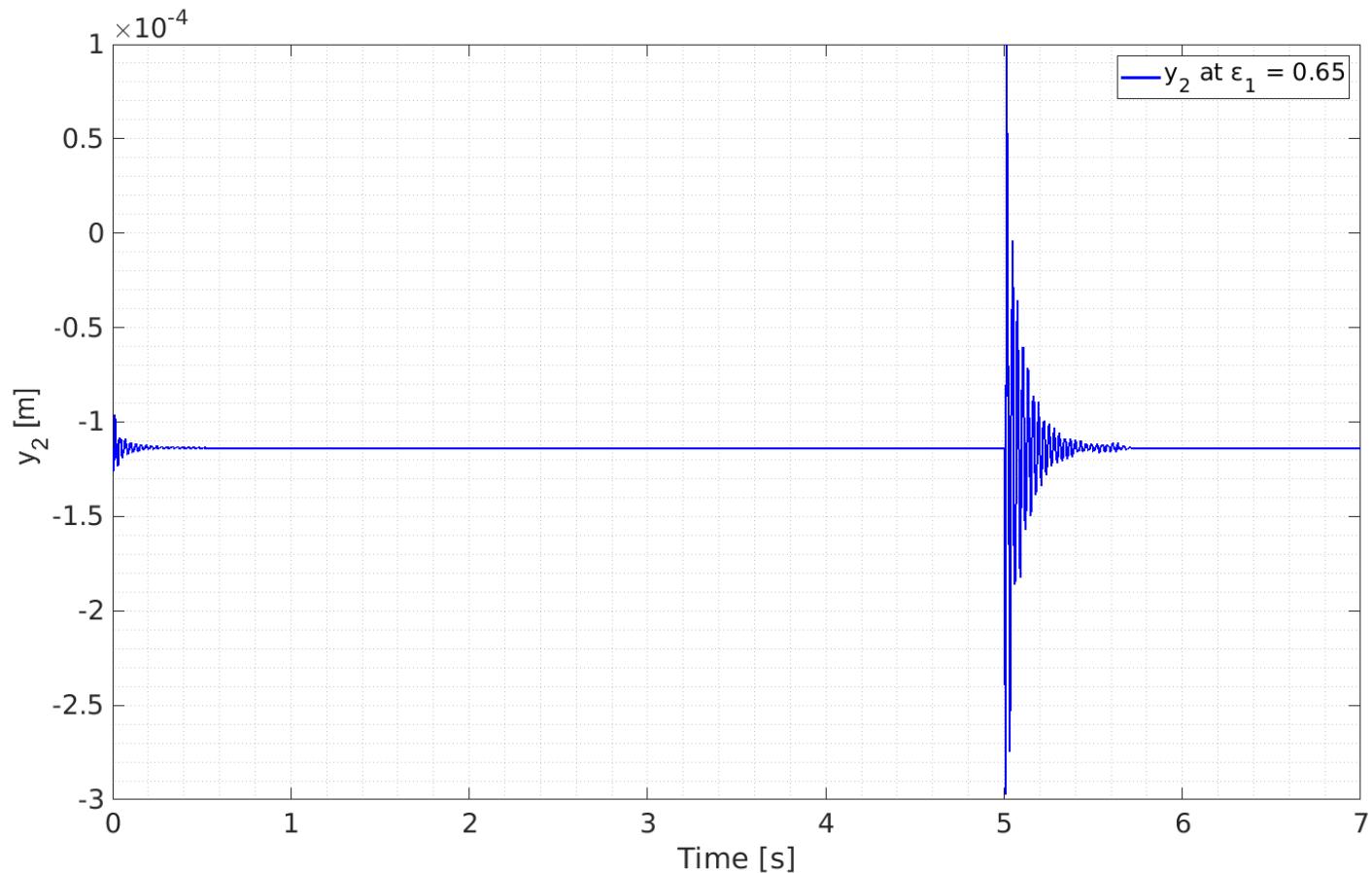
Position-Time plot of a system reaction to a voltage step from 0V to 2500V



Position-Time plot of a system reaction to a voltage step from 0V to 2500V



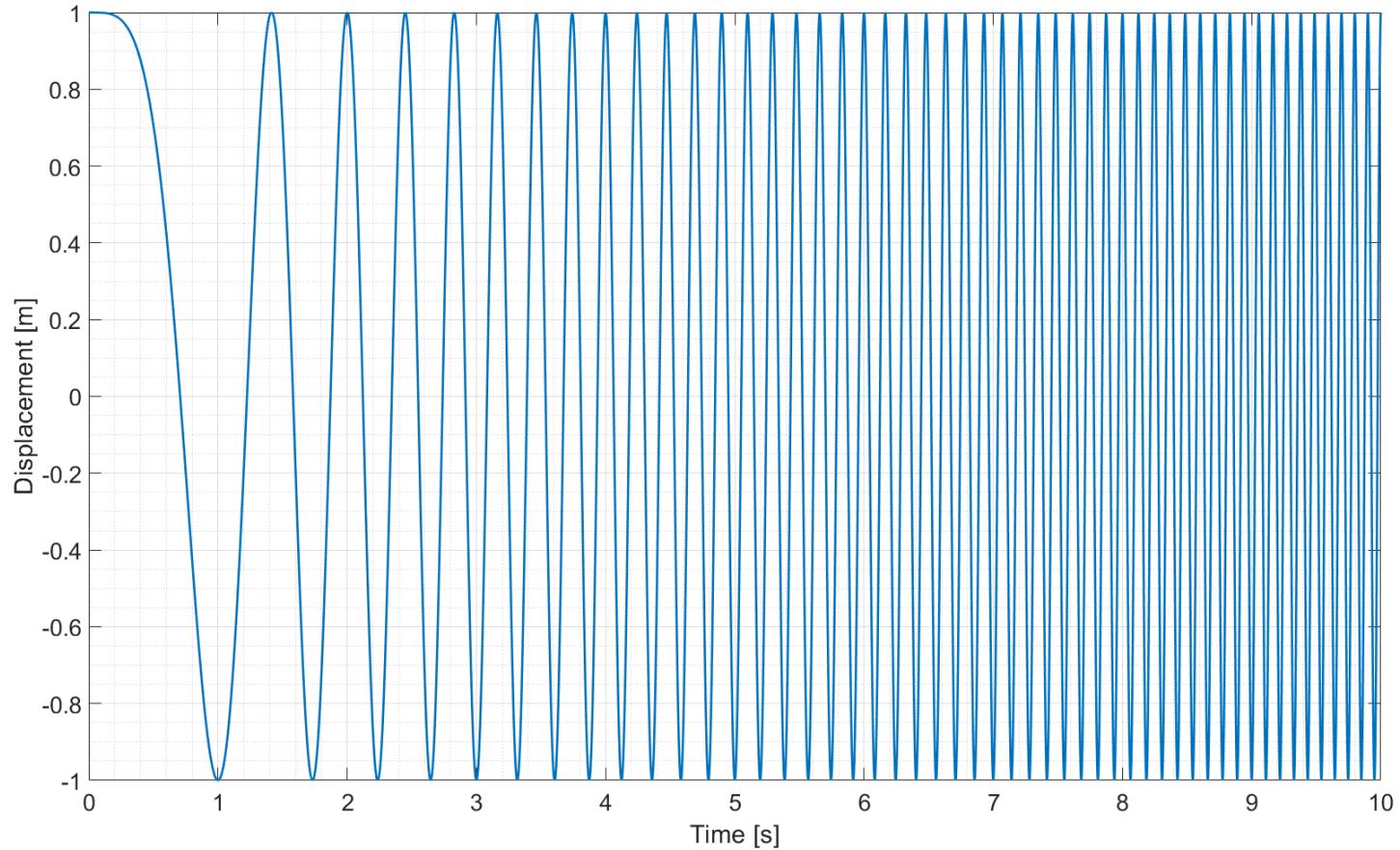
Position-Time plot of a system reaction to a voltage step from 0V to 2500V



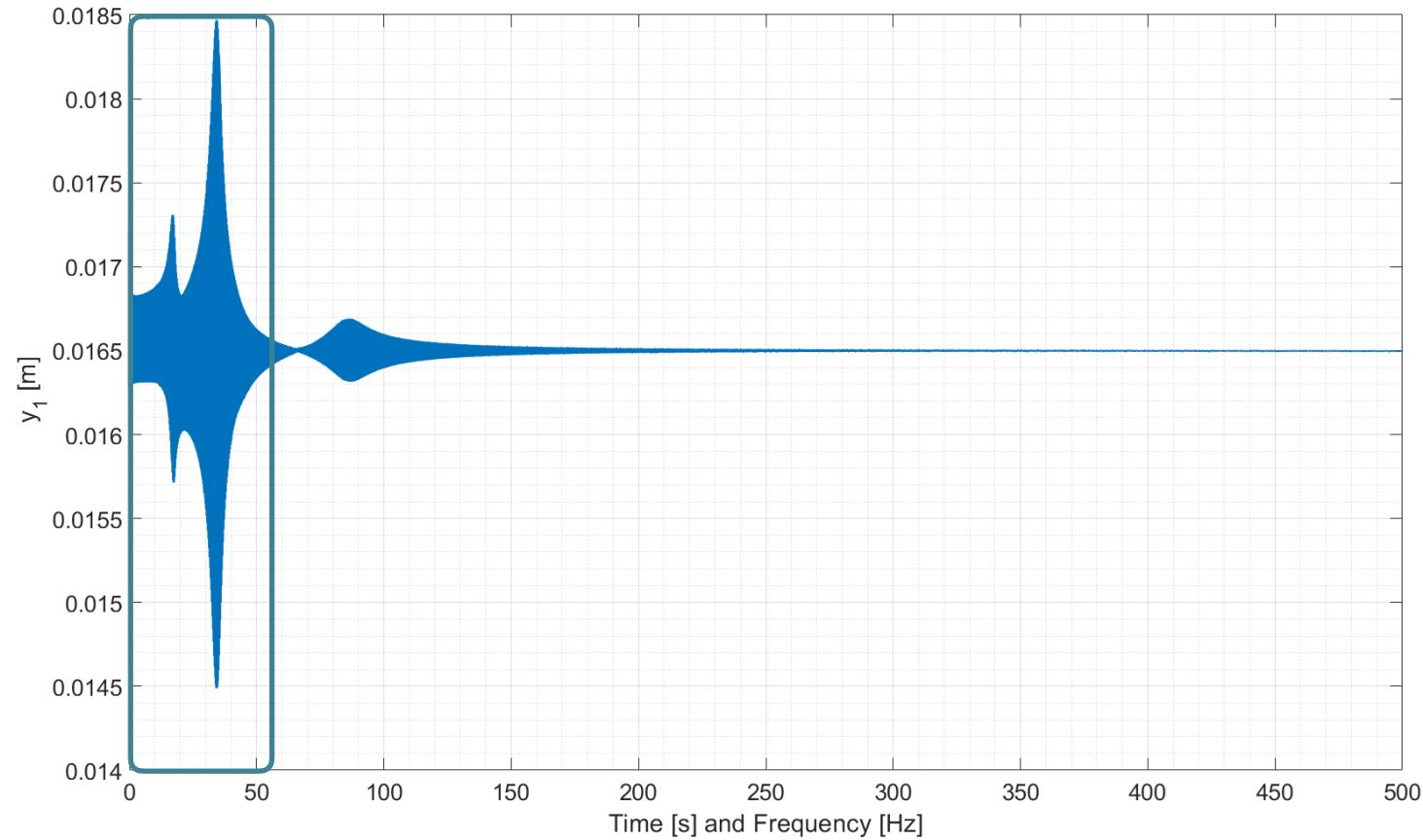
Position-Time plot of a system reaction to a voltage step from 0V to 2500V



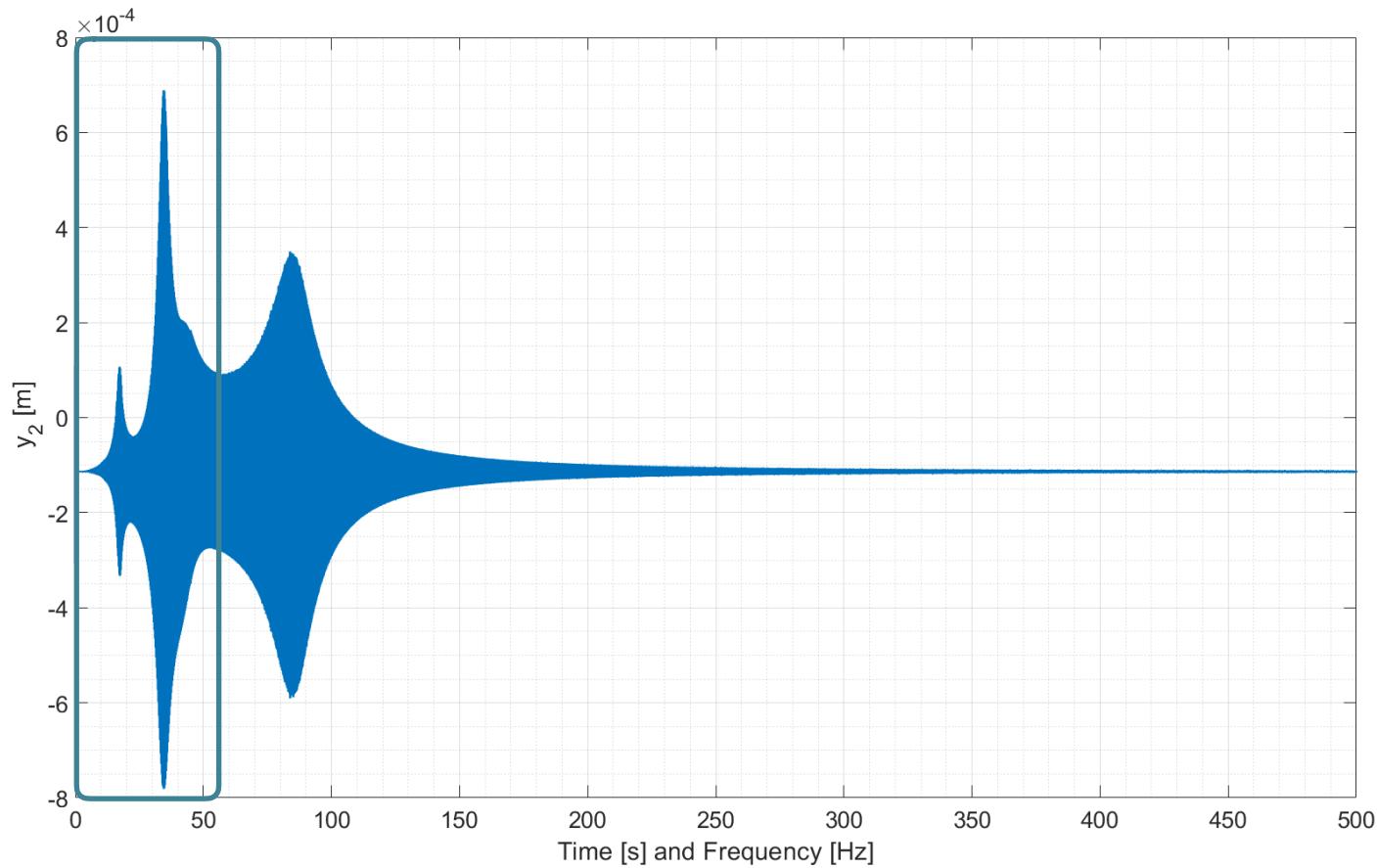
task 3 - DEA Frequency Response



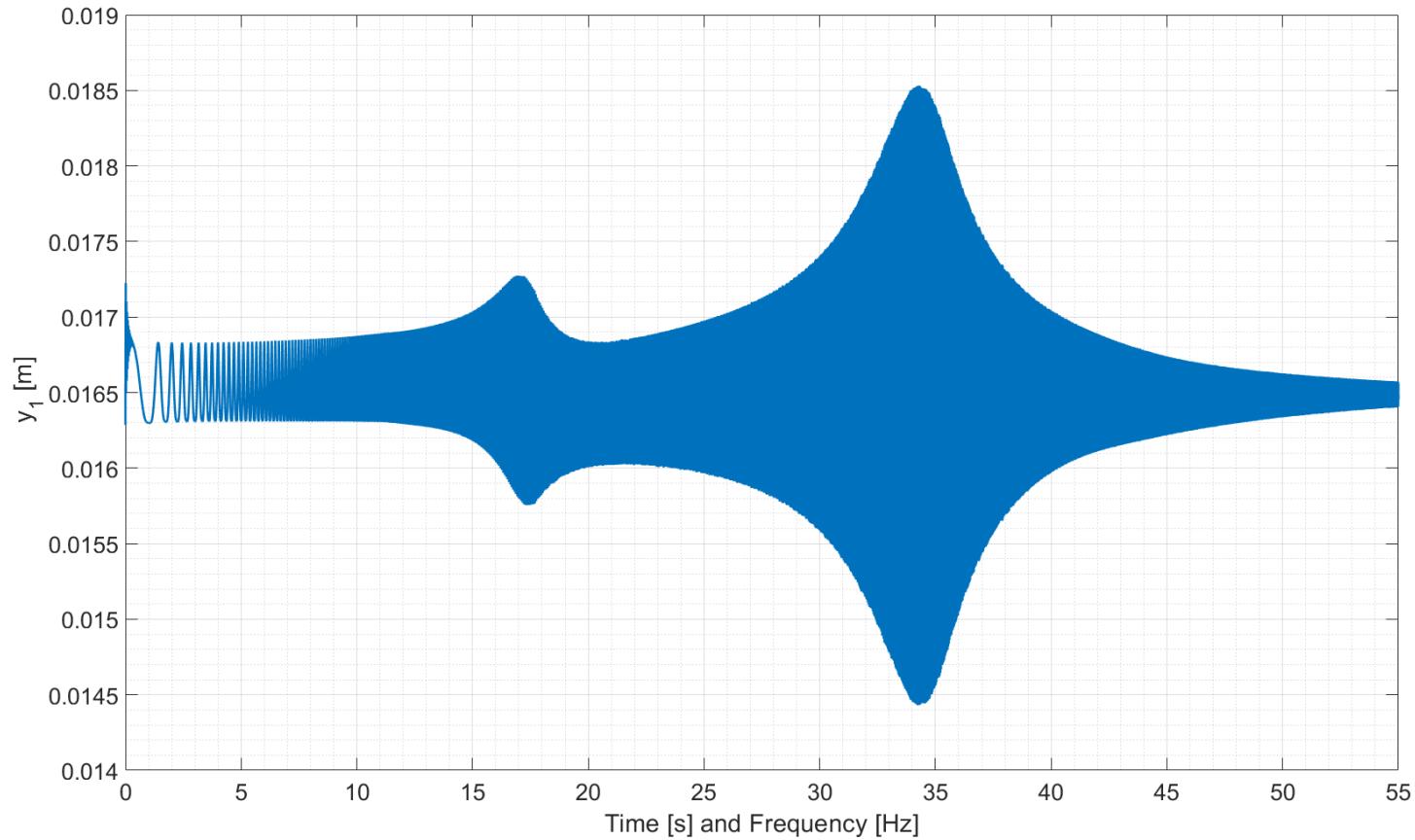
Sinesweep function to excite the DE and find the resonance and anti-resonance frequency



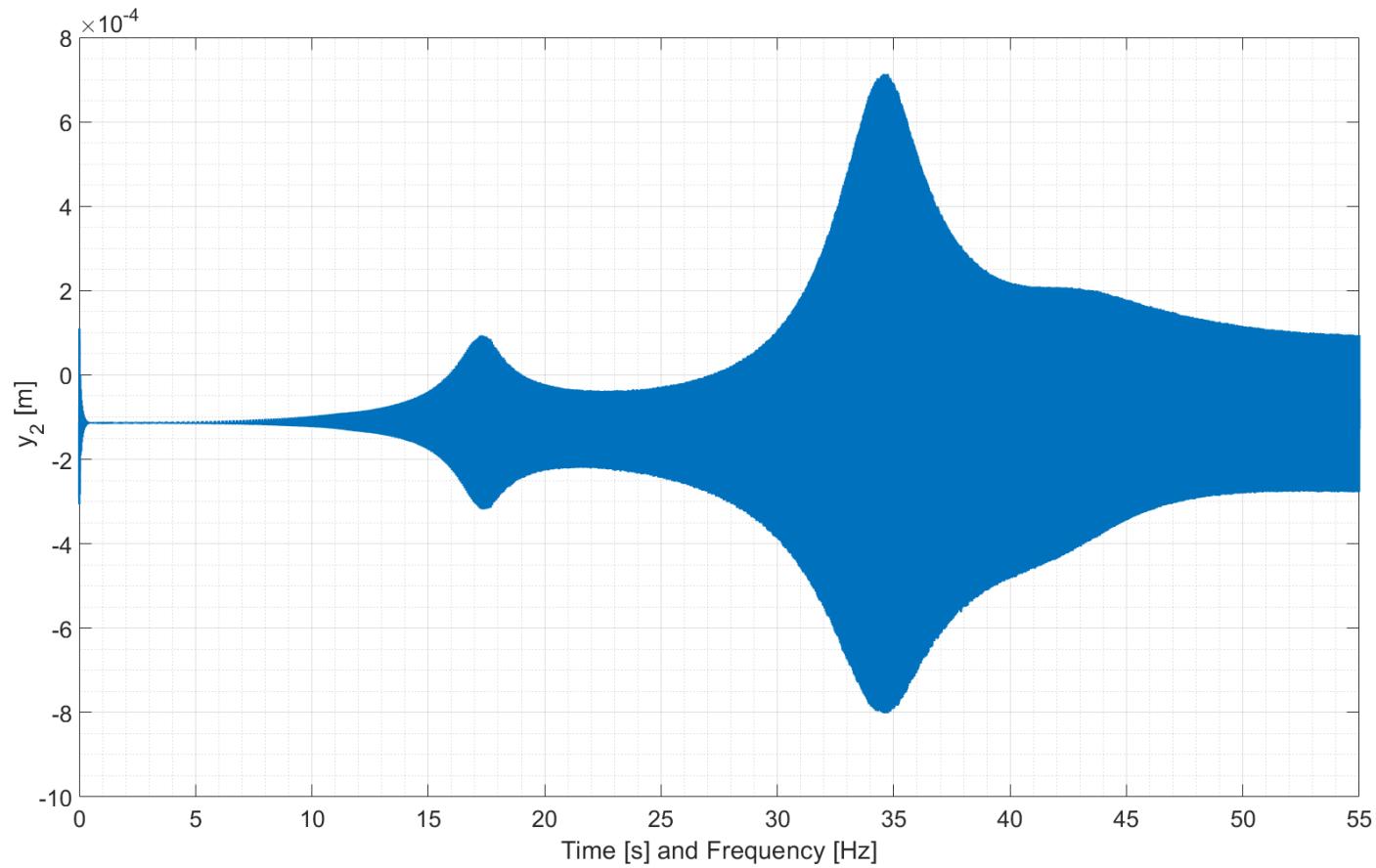
Position-Time plot of a DEA reaction to different voltage change frequencies



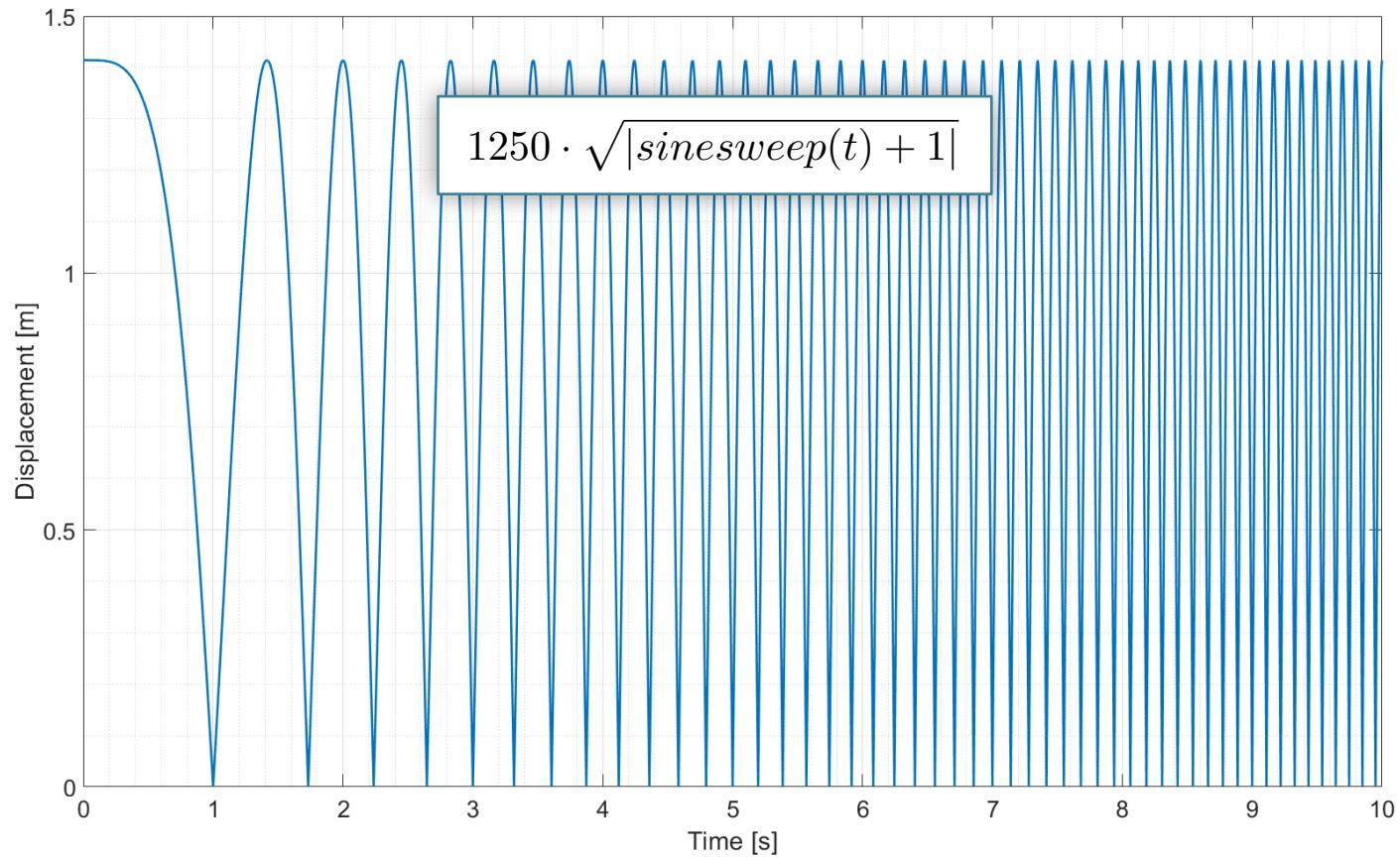
Position-Time plot of a DEA reaction to different voltage change frequencies



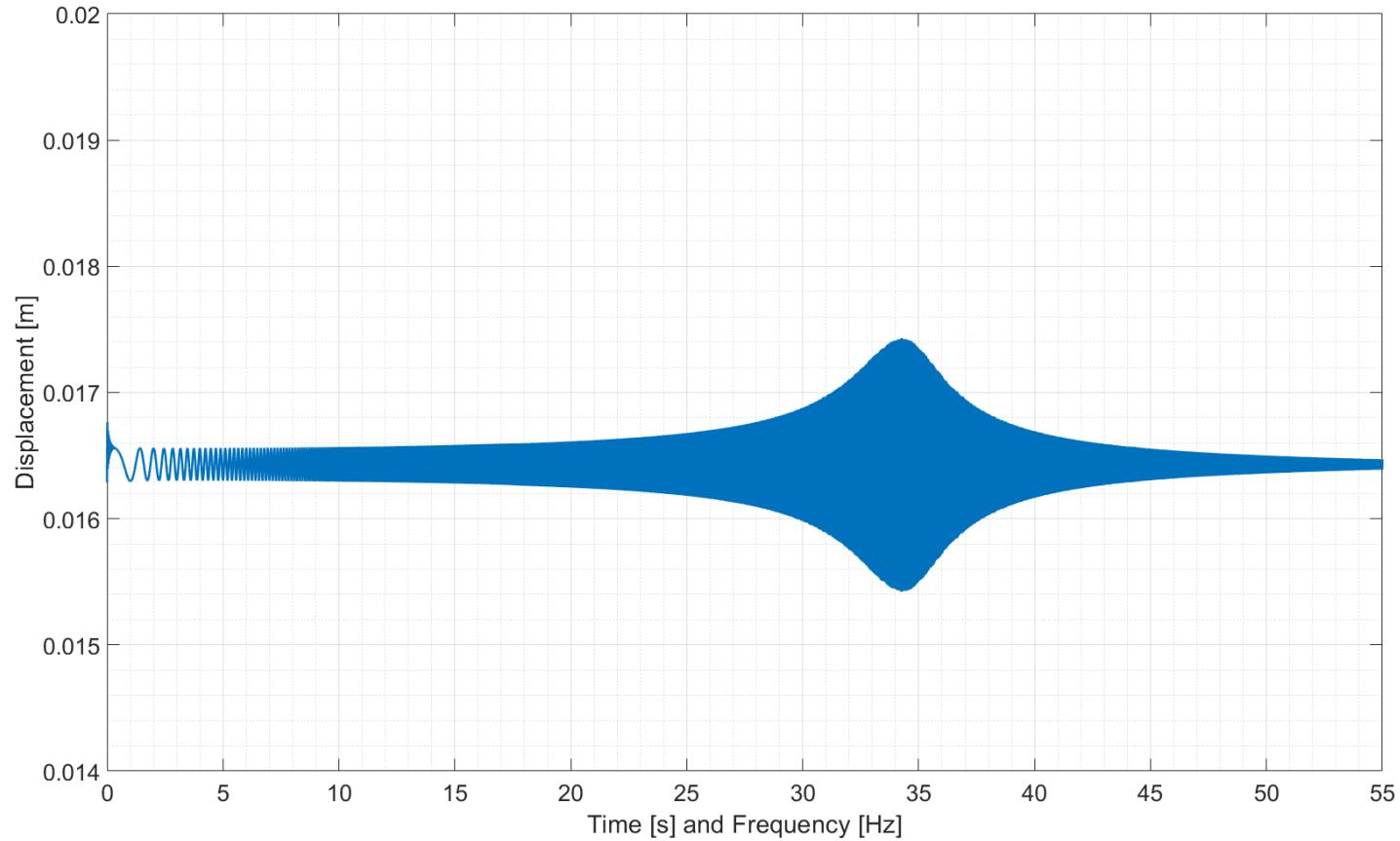
Position-Time plot of a DEA reaction to different voltage change frequencies



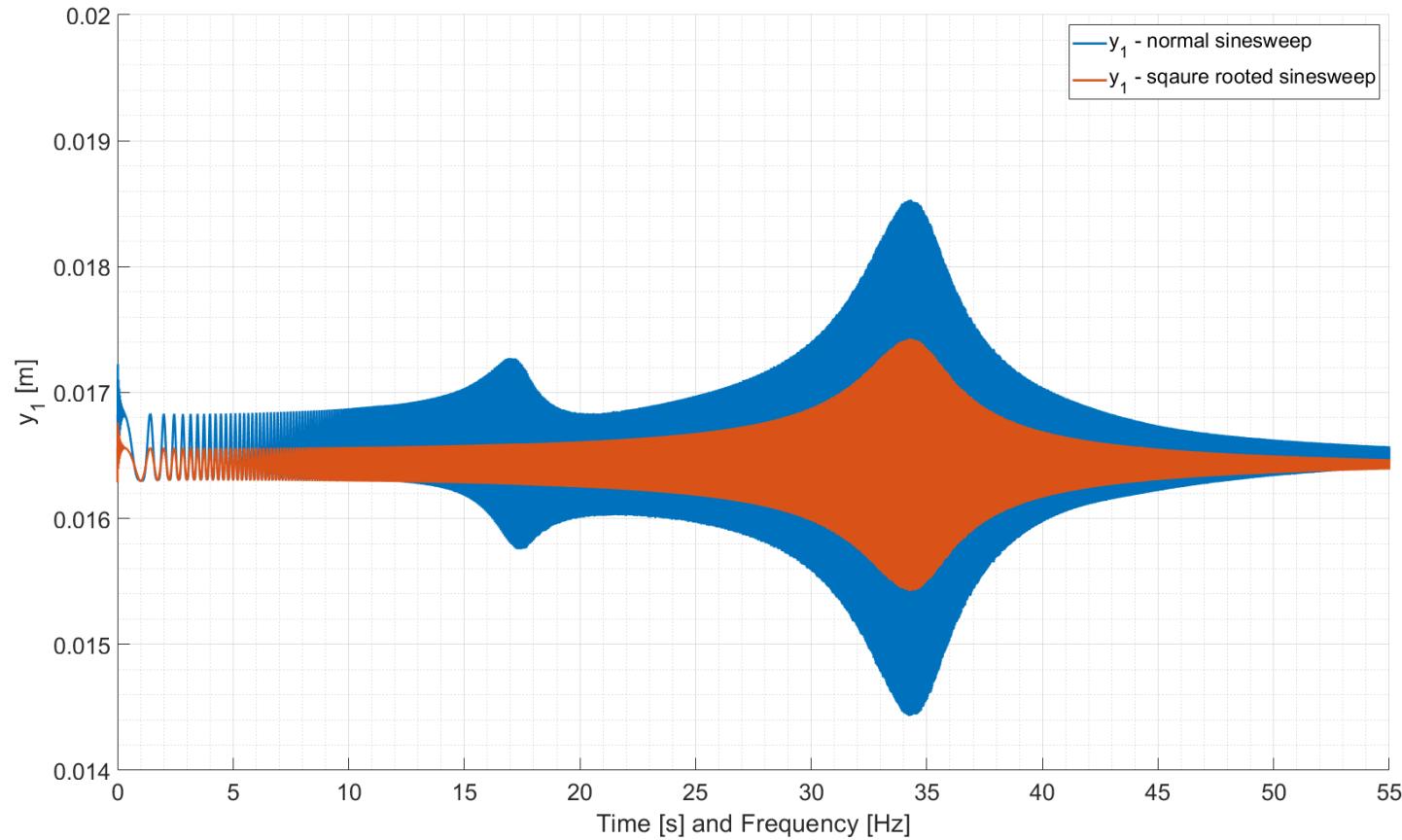
Position-Time plot of a DEA reaction to different voltage change frequencies



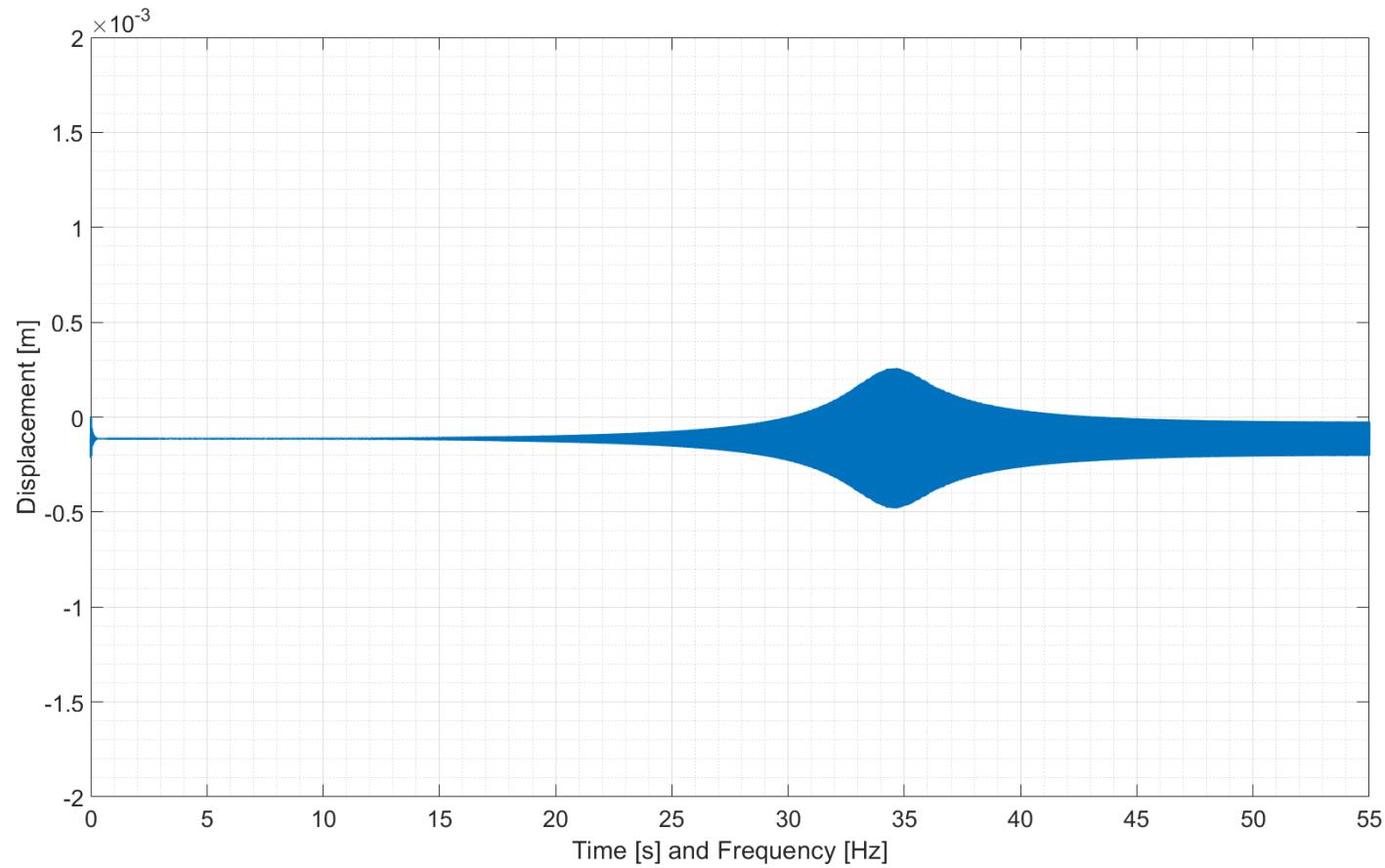
square rooted Sinesweep function to excite the DE and find the resonance and anti-resonance frequency



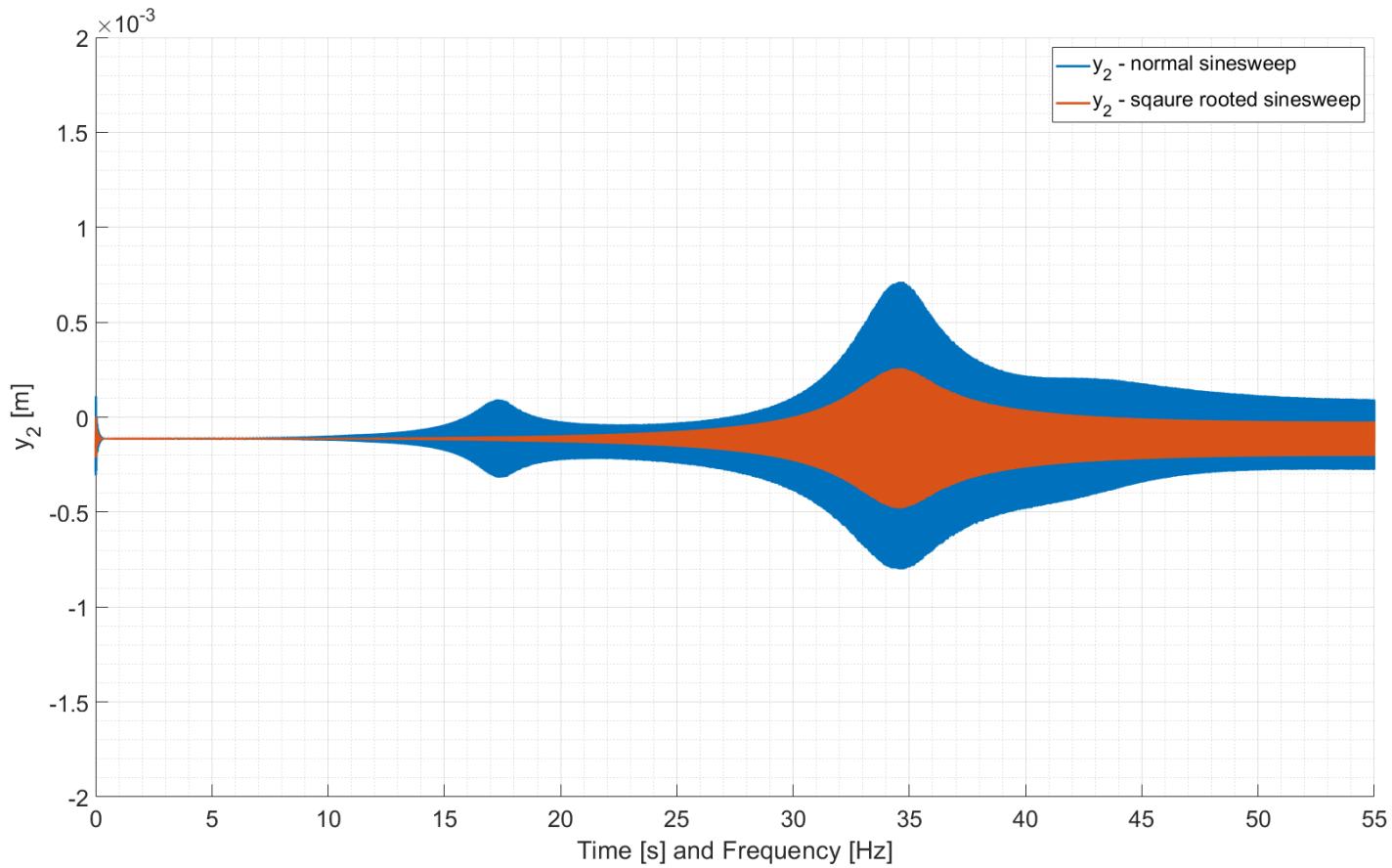
Position-Time plot of a DEA reaction to different voltage change frequencies



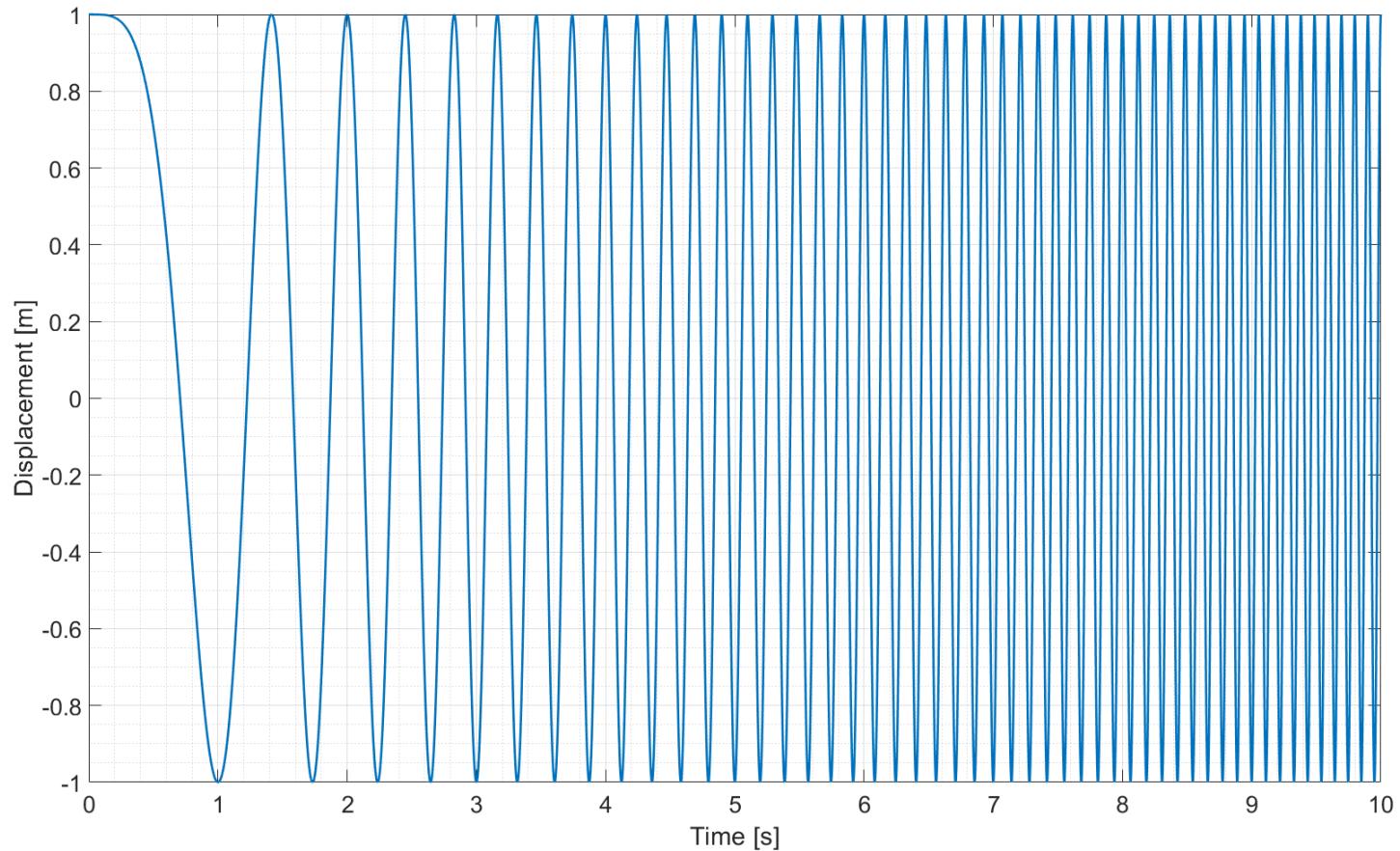
Position-Time plot of a DEA reaction to different voltage change frequencies



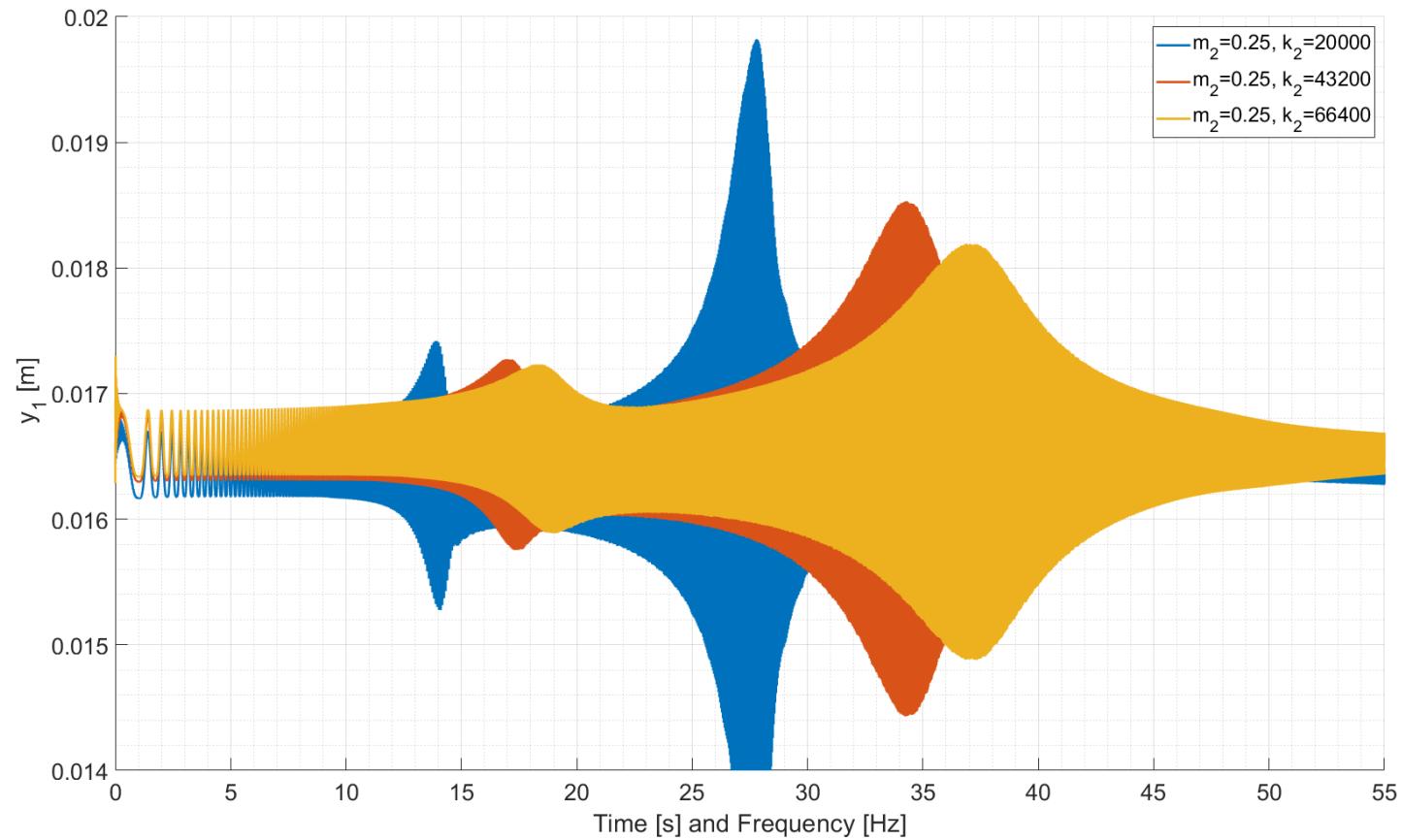
Position-Time plot of a DEA reaction to different voltage change frequencies



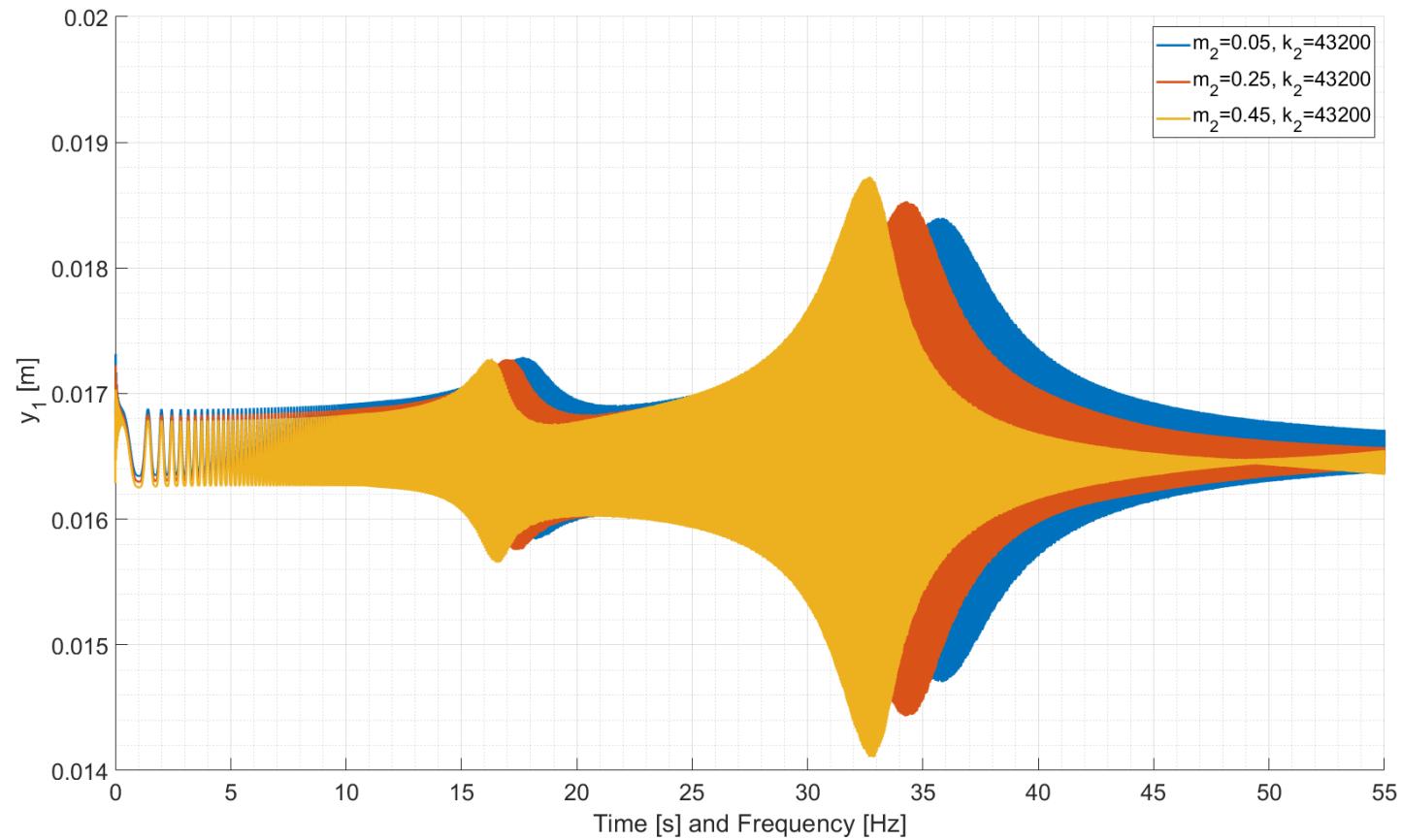
Position-Time plot of a DEA reaction to different voltage change frequencies



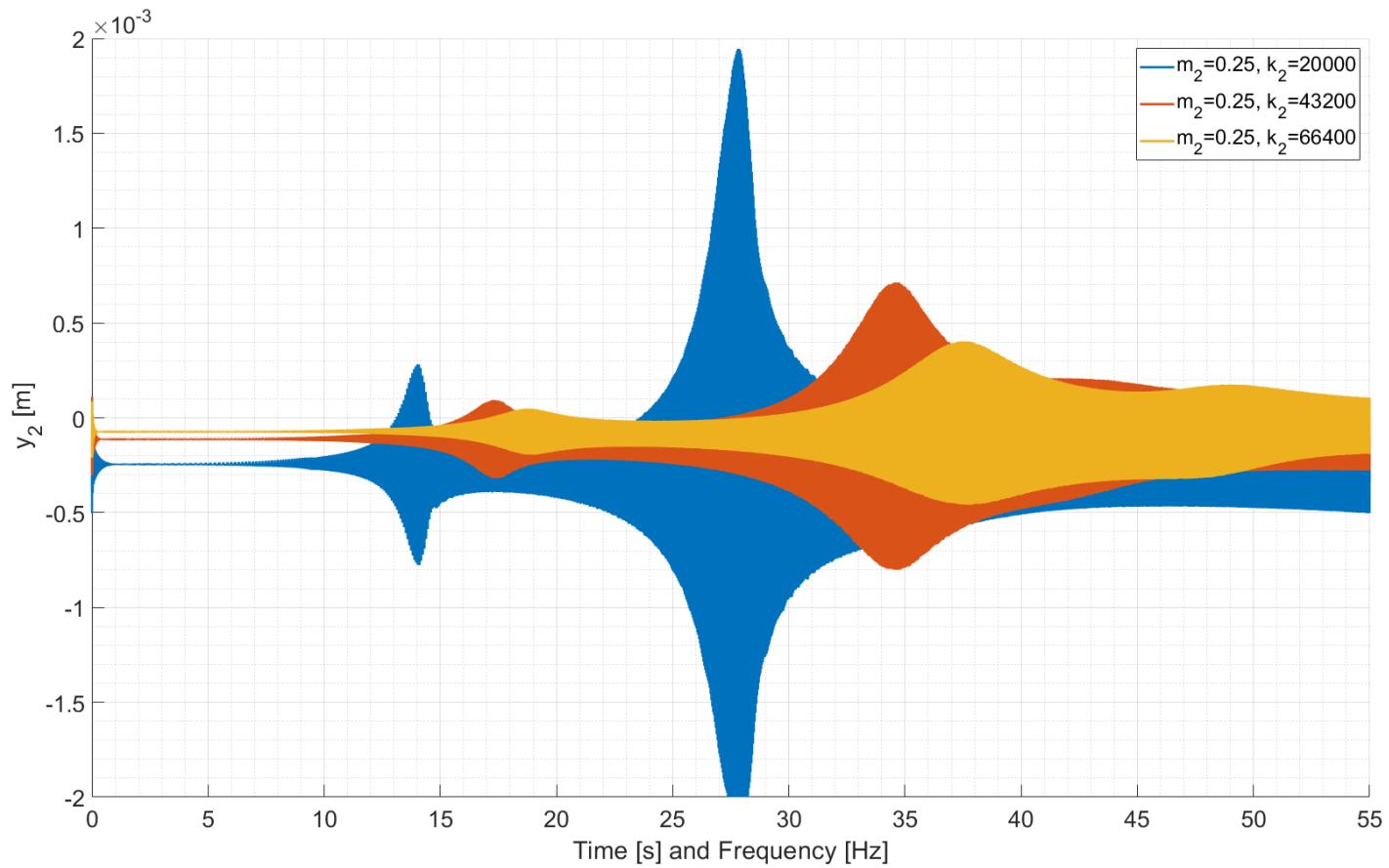
Sinesweep function to excite the DE and find the resonance and anti-resonance frequency



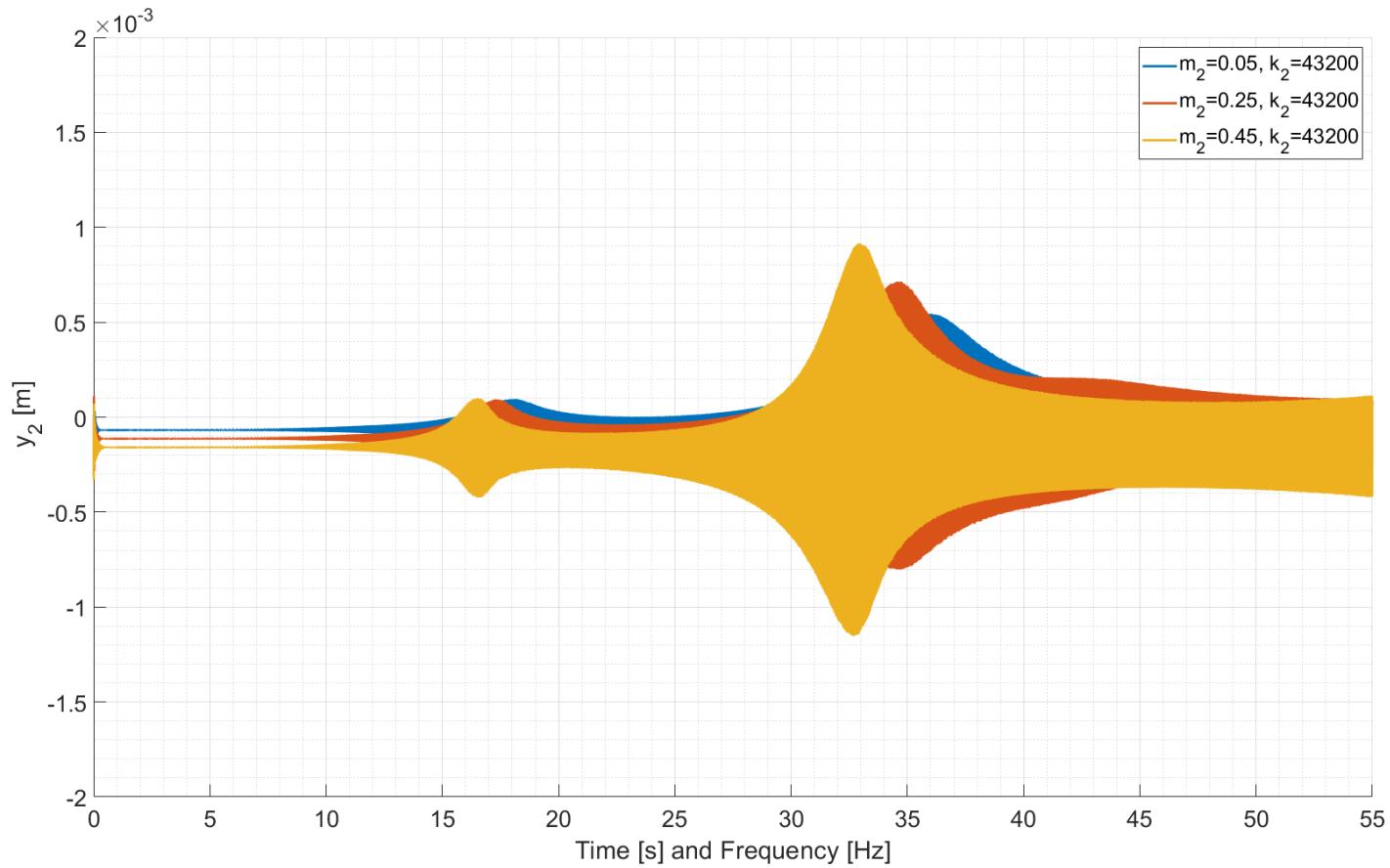
Position-Time plot of a DEA reaction to different spring constants



Position-Time plot of a DEA reaction to different masses



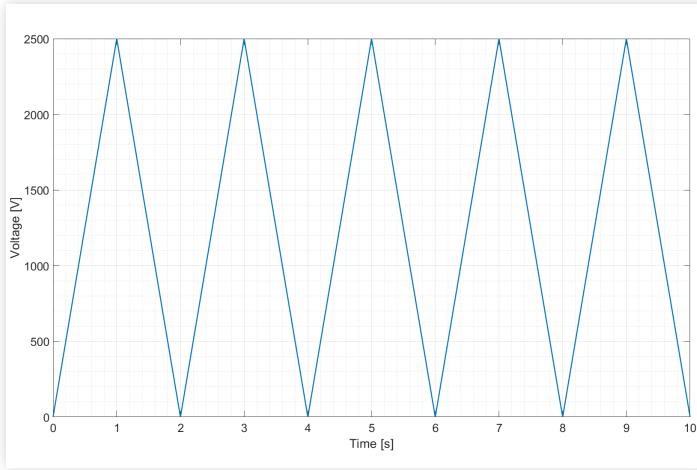
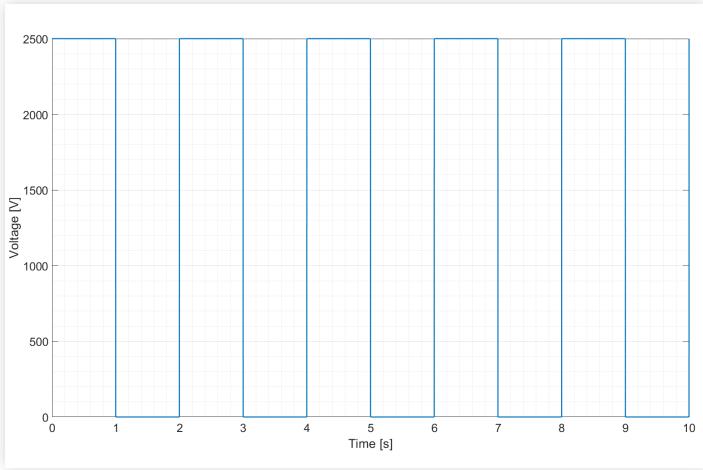
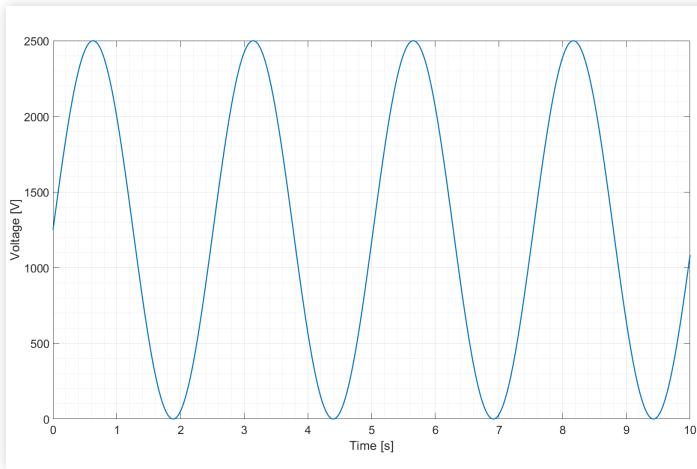
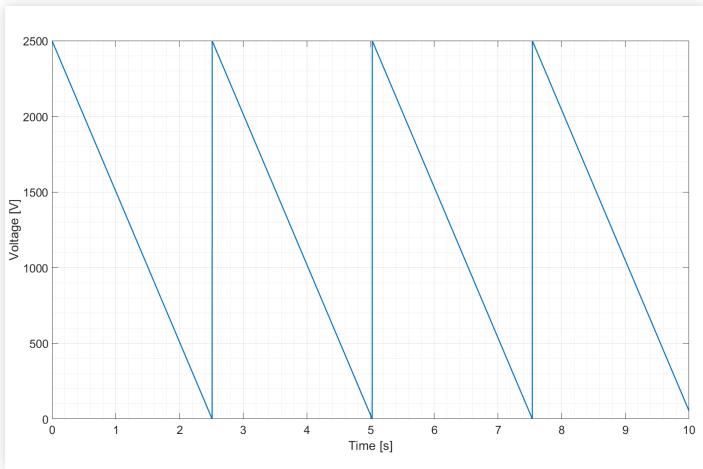
Position-Time plot of a DEA reaction to different spring constants

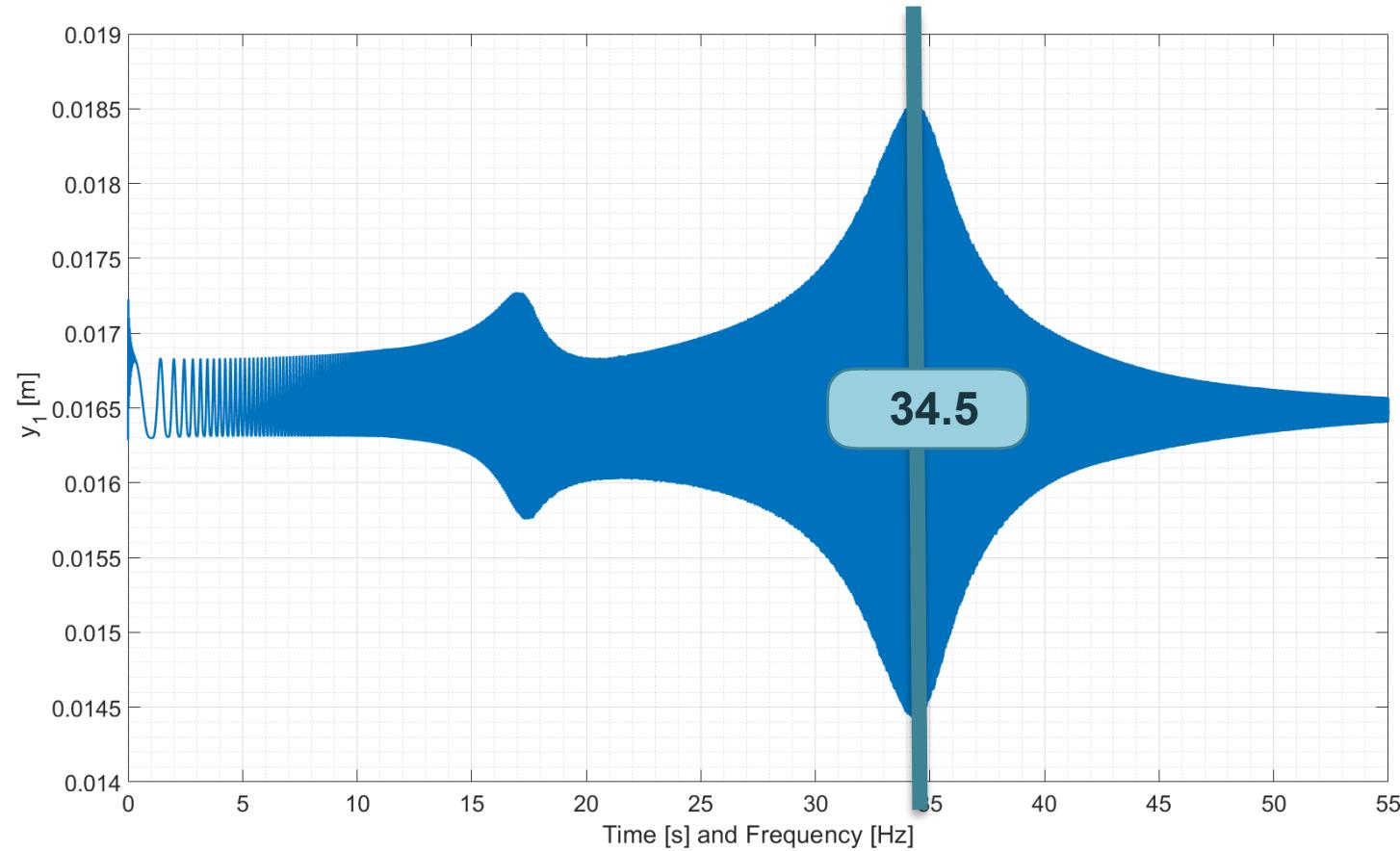


Position-Time plot of a DEA reaction to different masses

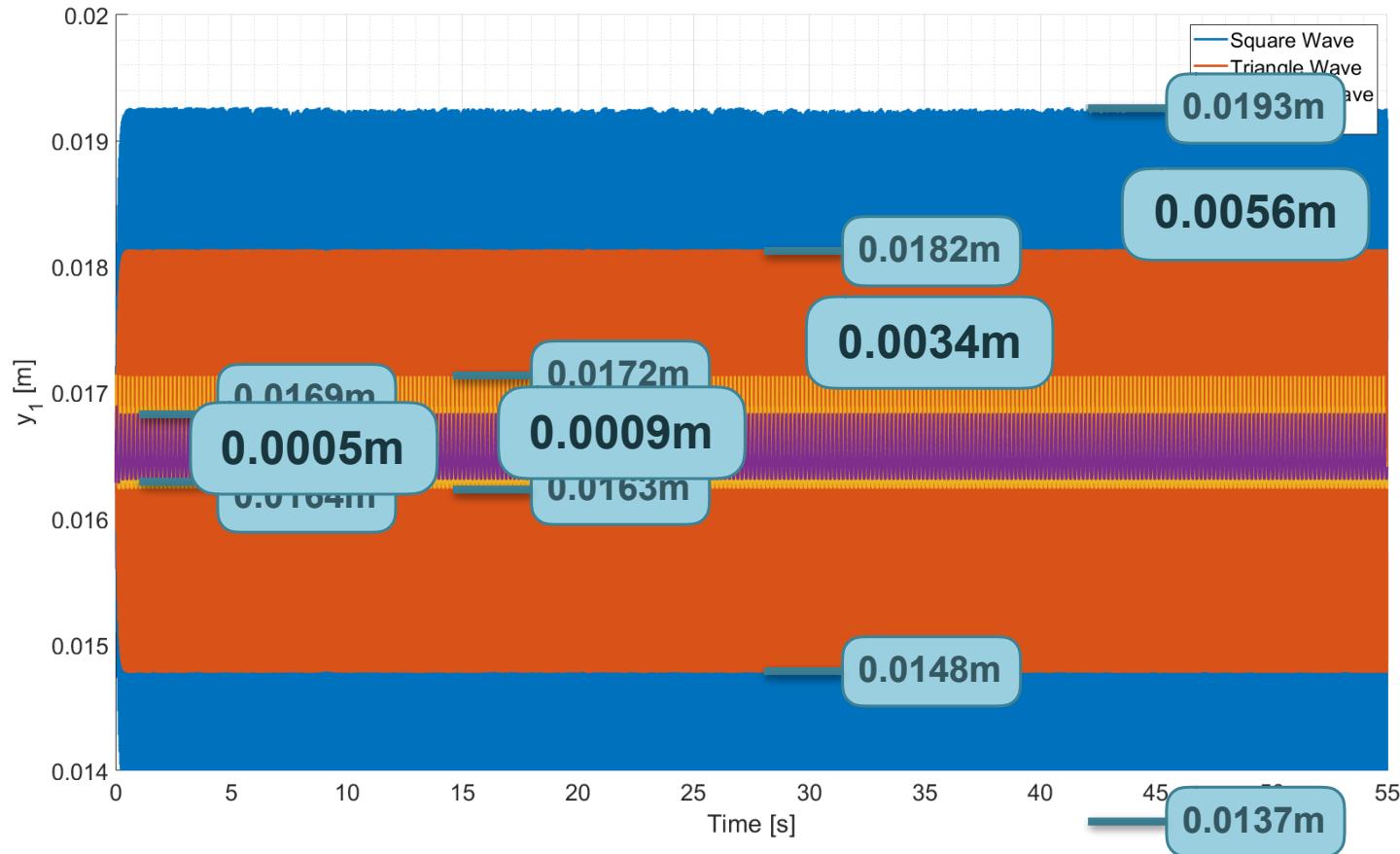


task 6 - Stroke and Power Consumption for Different Signals





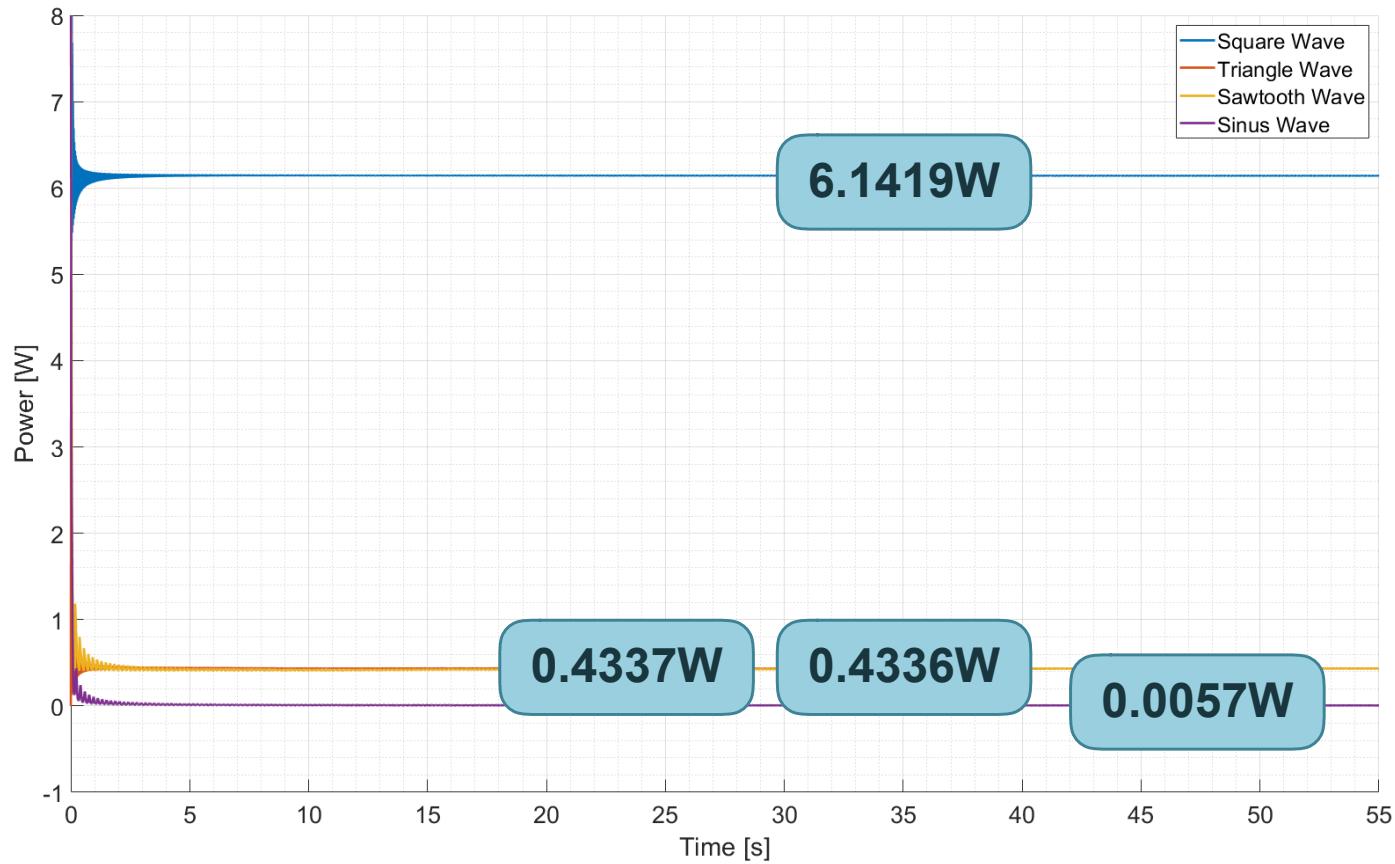
Position-Time plot of a DEA to detect the frequency with maximum stroke



Position-Time plot of a DEA reaction to different signal types



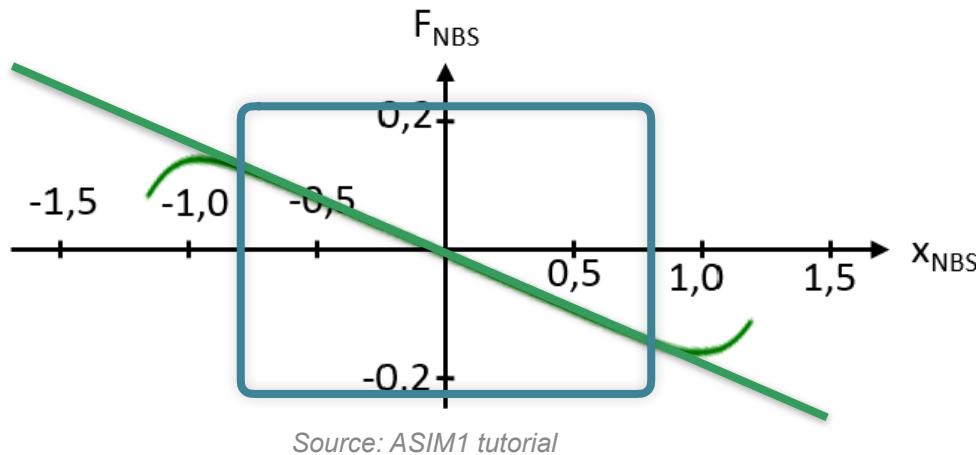
task 6 - Power Consumption

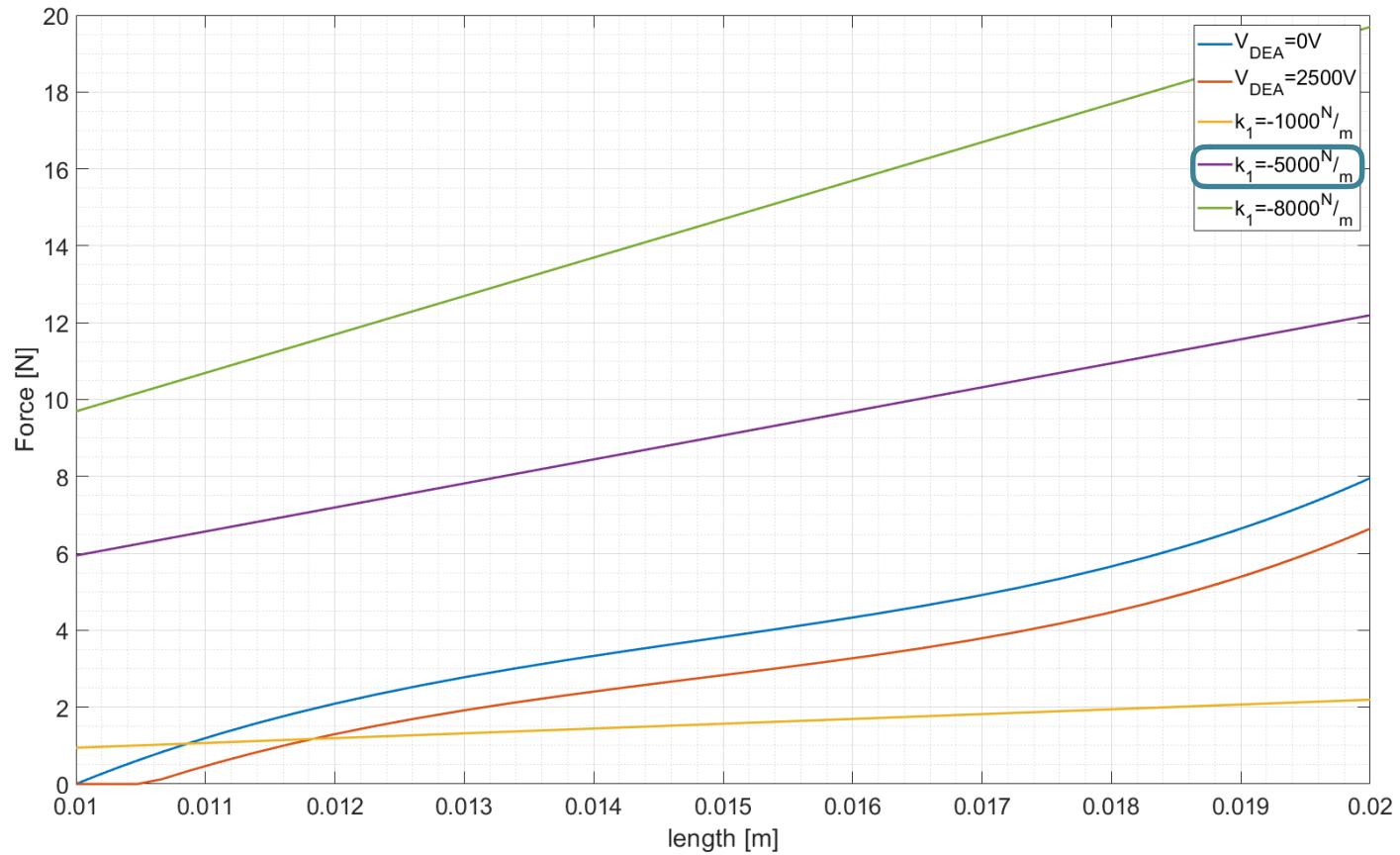


Time-Power consumption plot of a DEA for different signal types

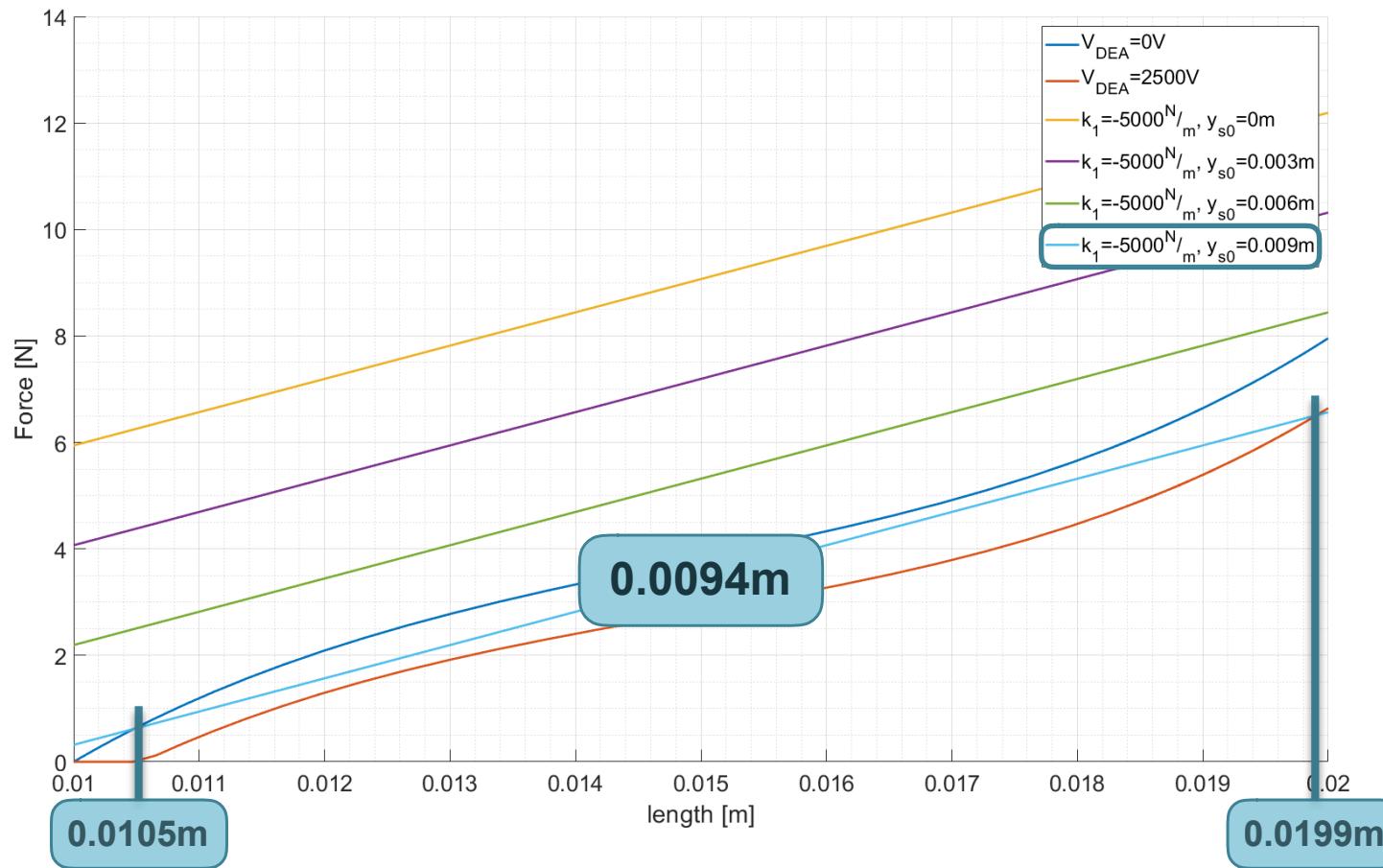
task 7 - Negative Bias Spring

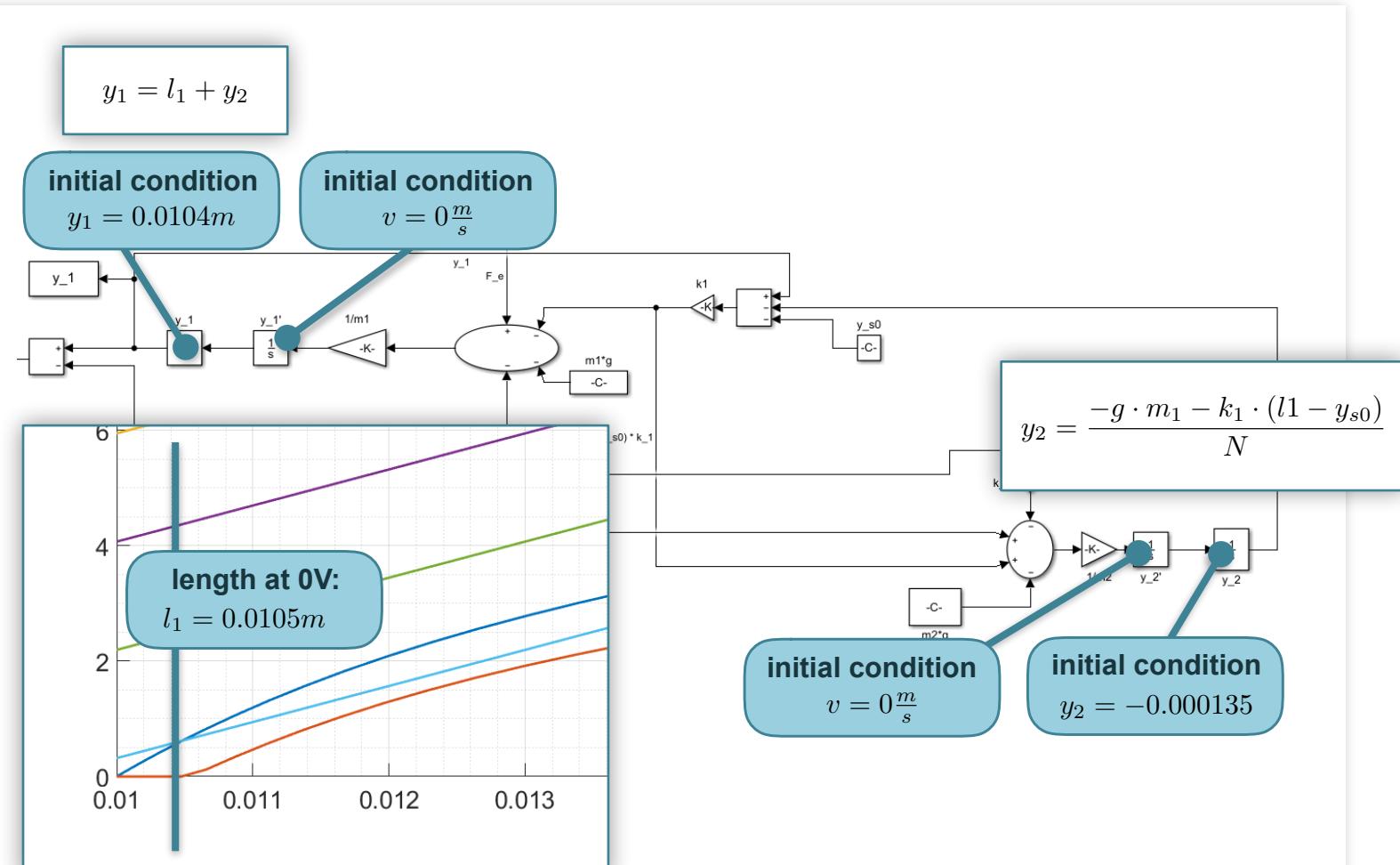
- replaced spring with NBS
- get a bigger stroke



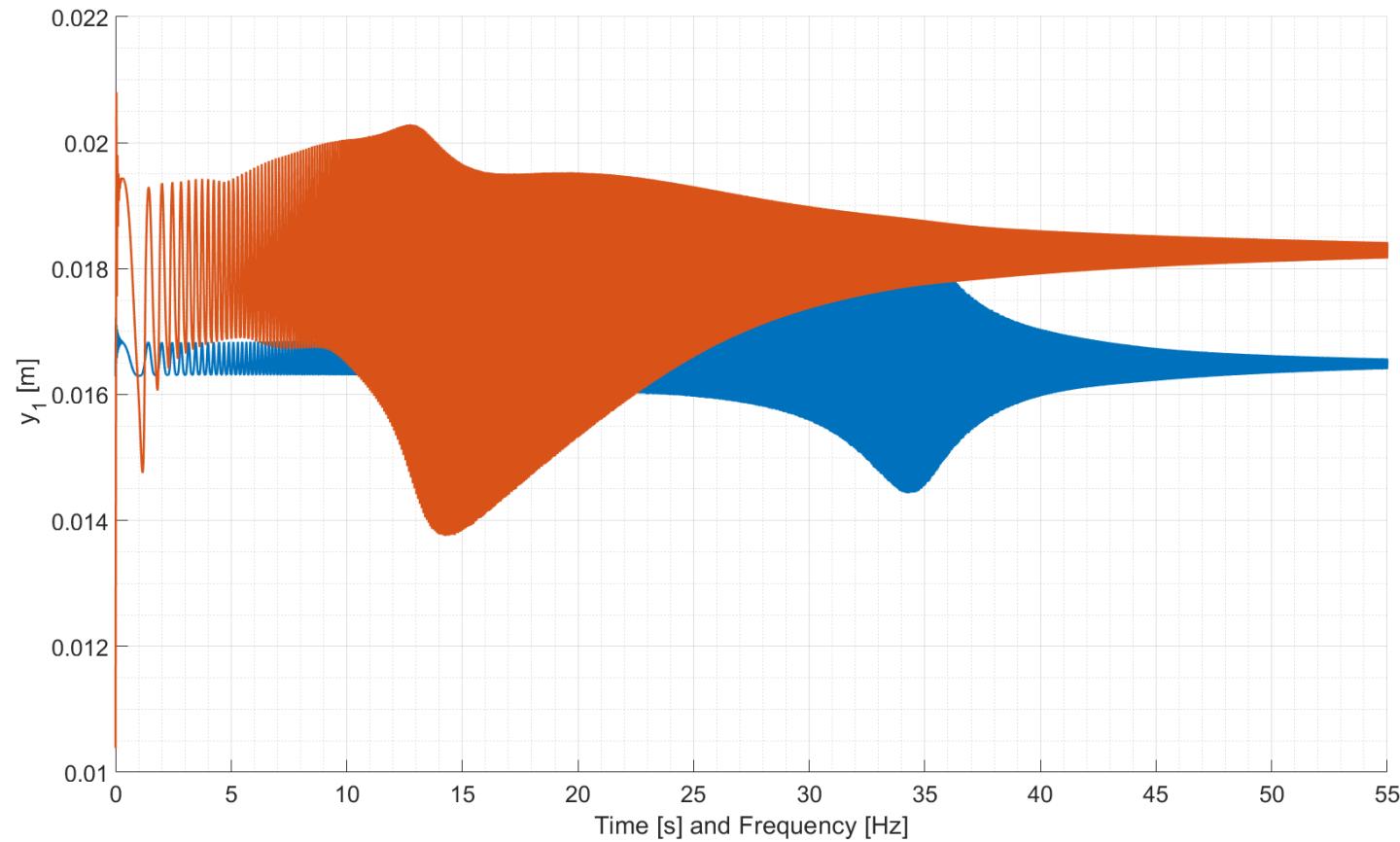


Force-Length plot of the DEA with different spring constant values

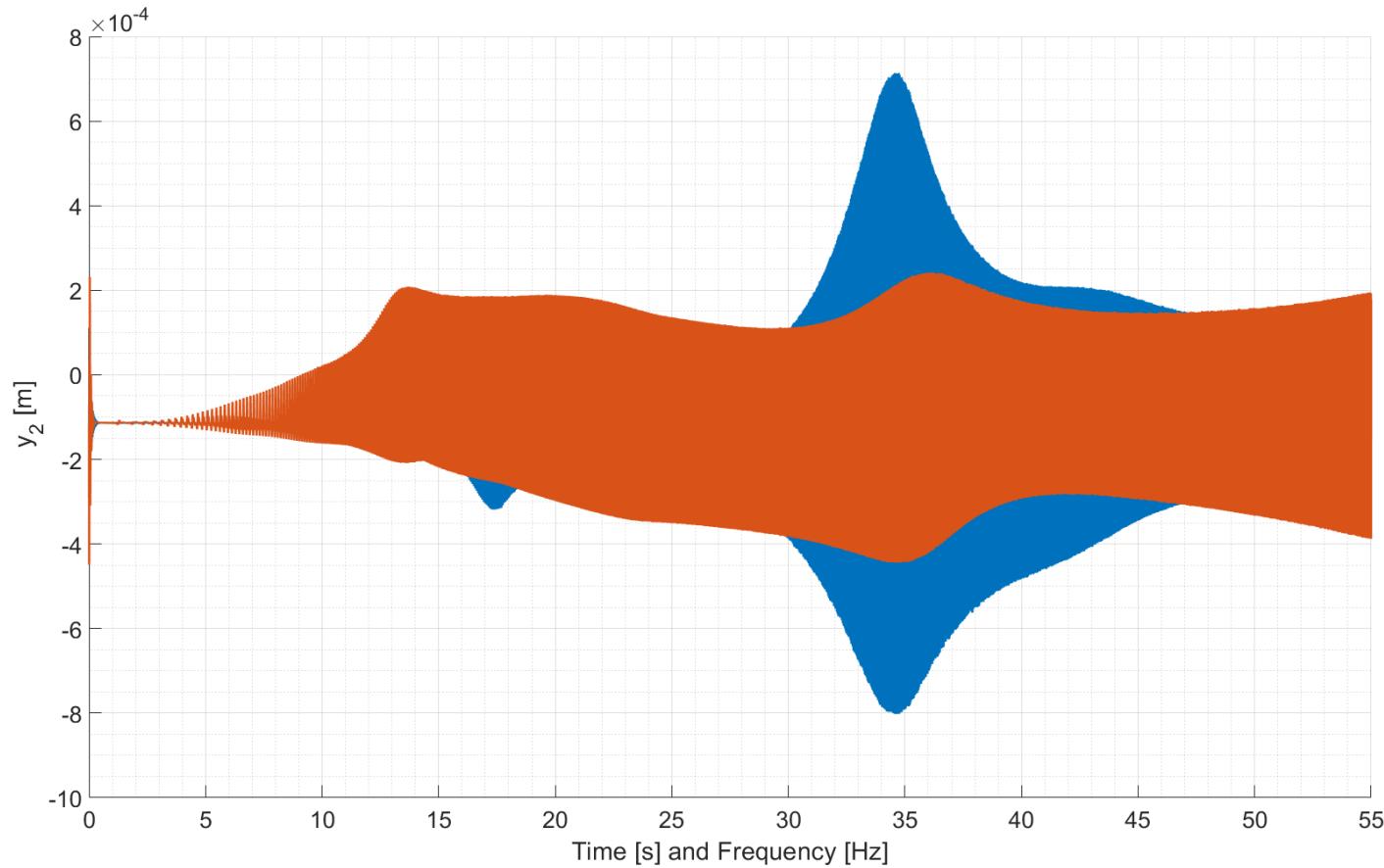




Simulink block diagram of the system



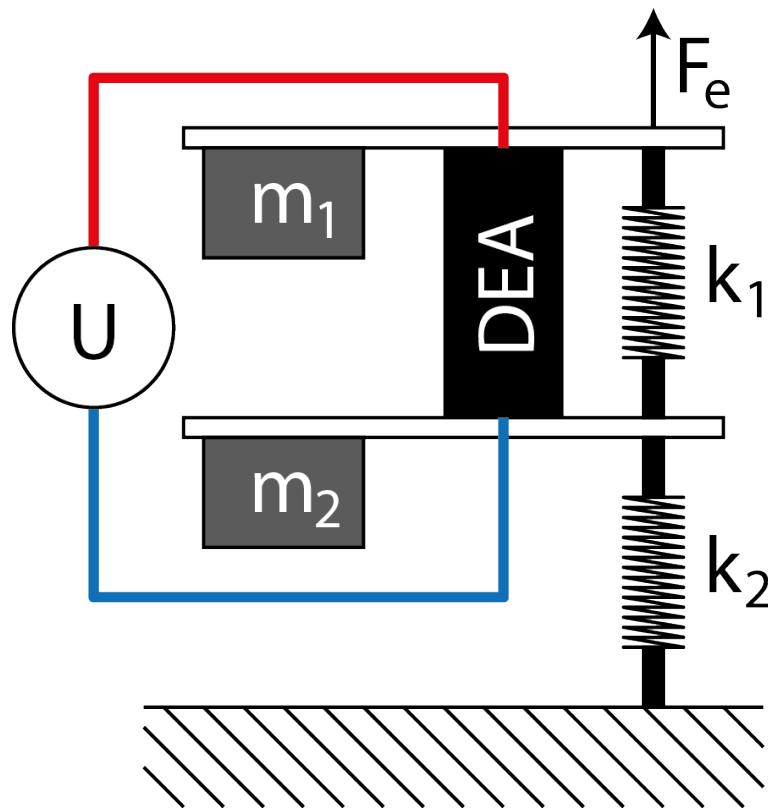
Position-Time plot of a DEA reaction to different voltage change frequencies with a negative spring bias



Position-Time plot of a DEA reaction to different voltage change frequencies with a negative spring bias

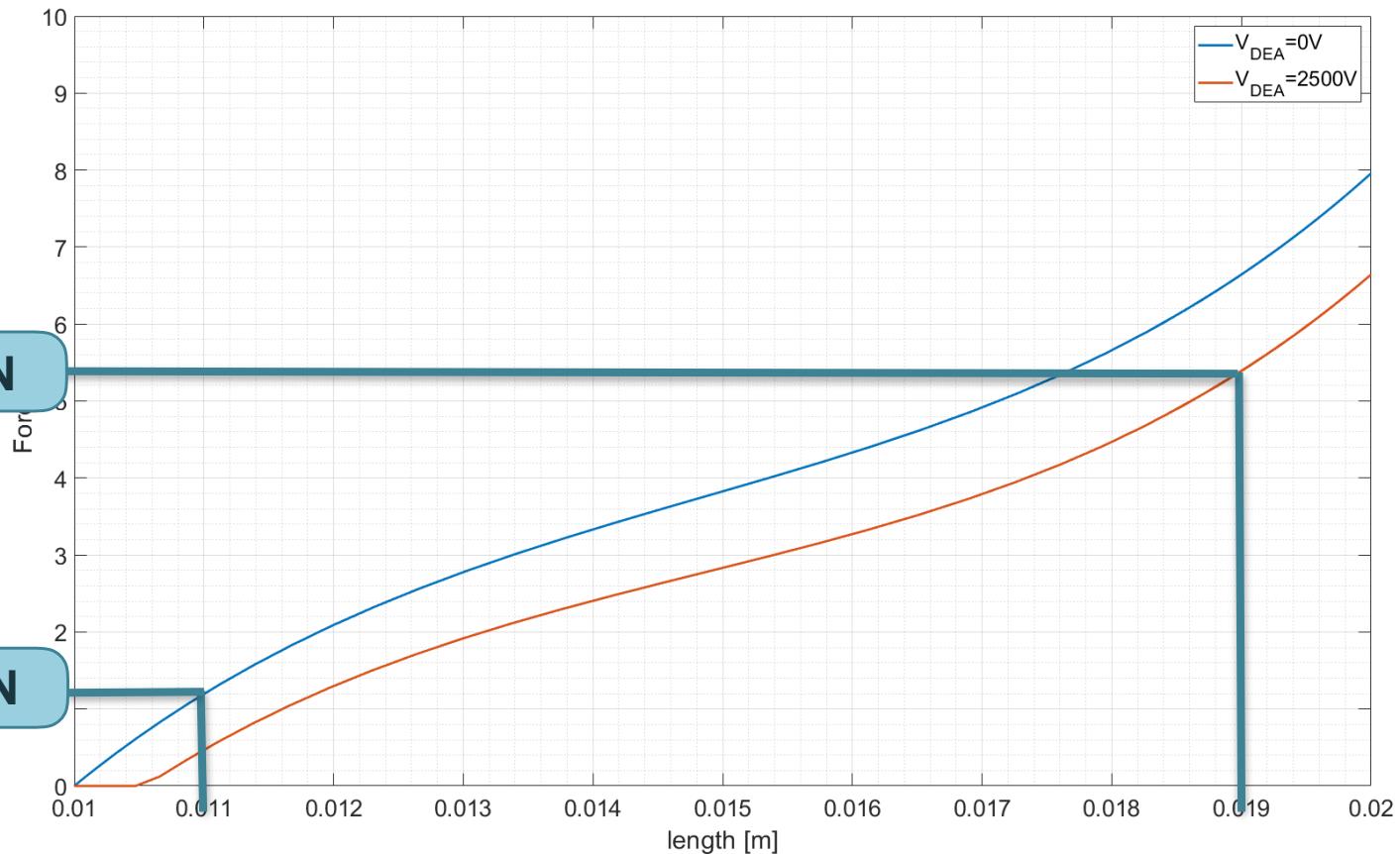
task 8 - DEA Generator

- external force F_e
- determine $F_{e,\min}$ and $F_{e,\max}$
- plot efficiency and power





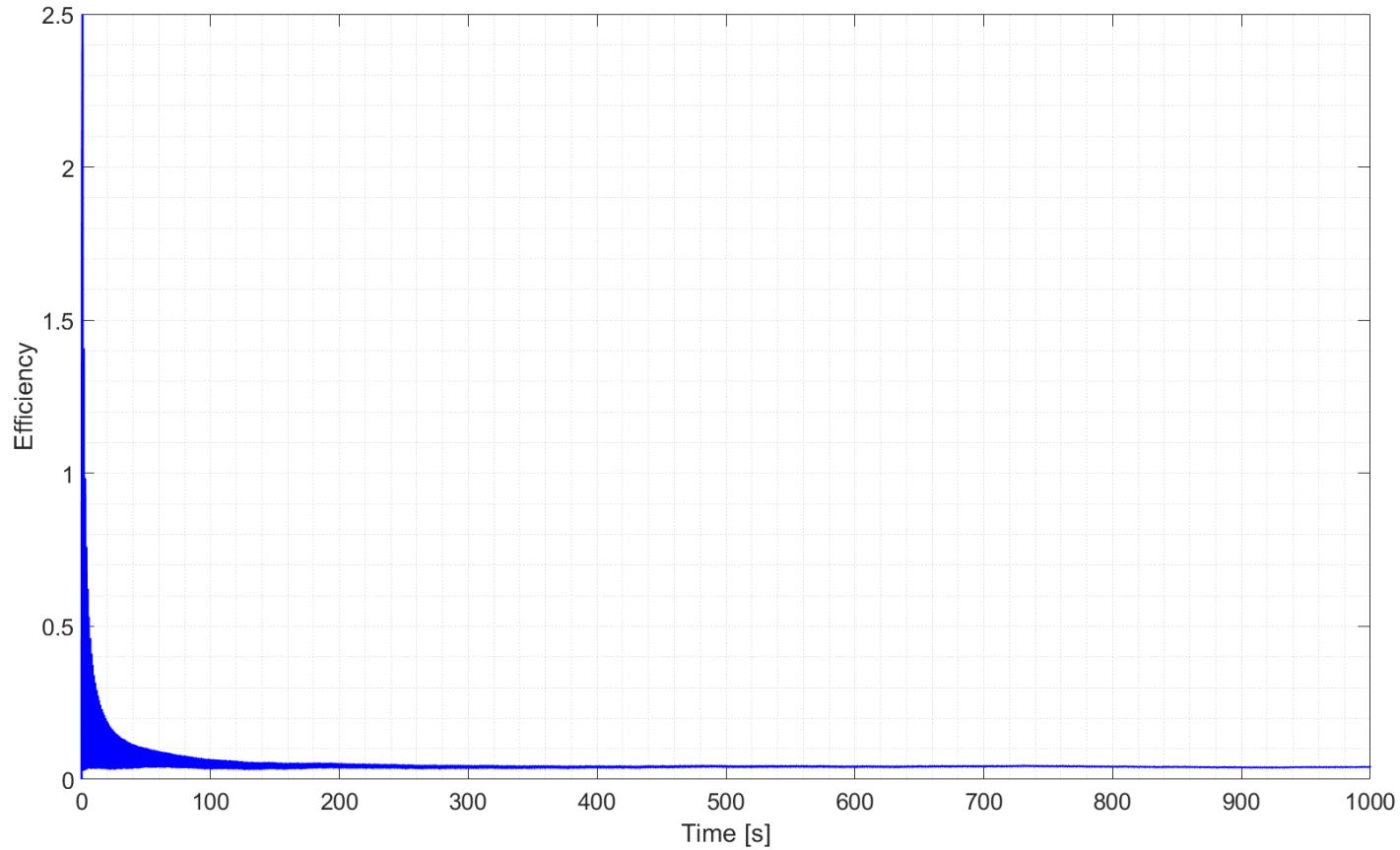
task 8 - Determine $F_{e,min}$ and $F_{e,max}$



Force-Length plot of the DEA to find values for $F_{e,min}$ and $F_{e,max}$



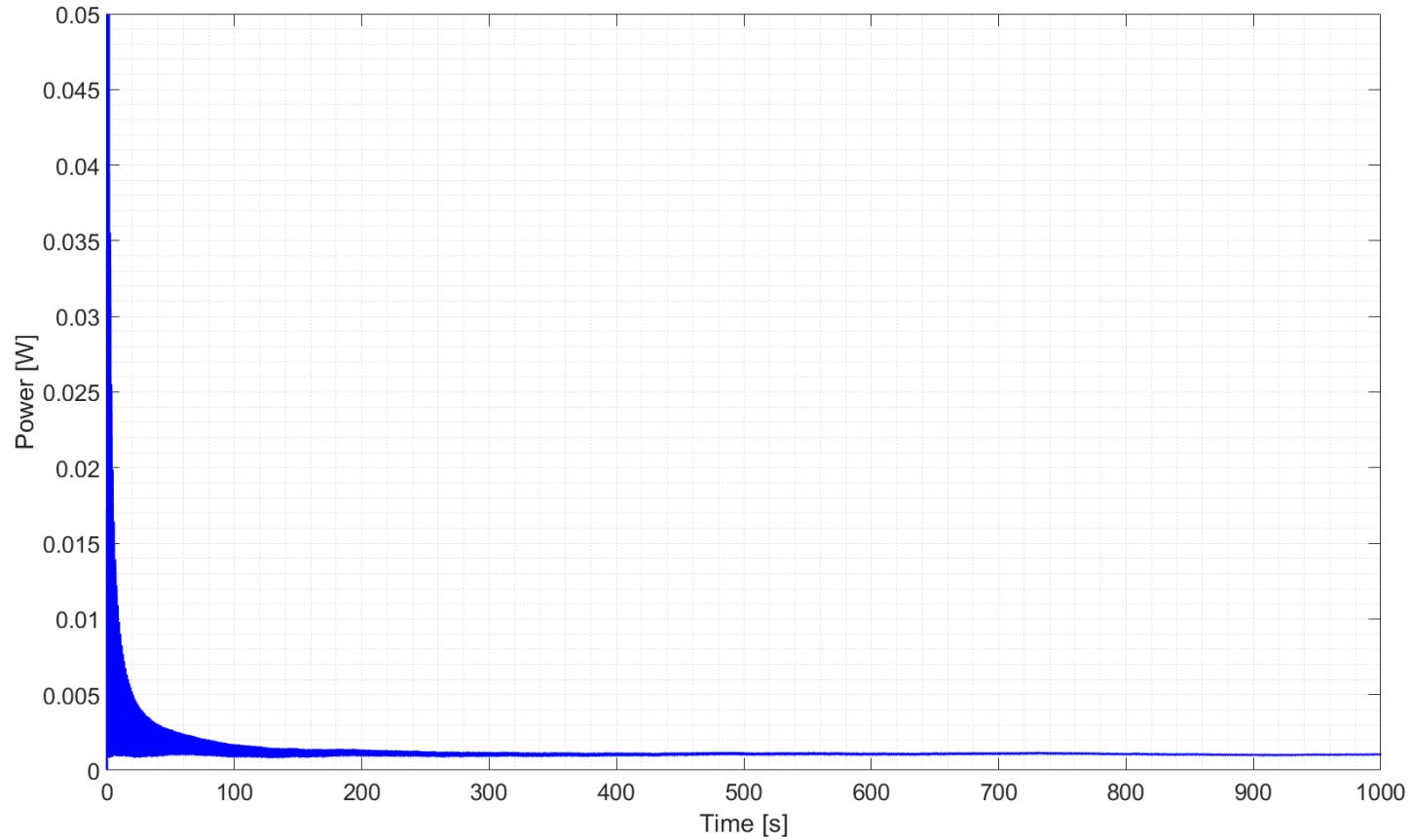
task 8 - Efficiency, $T = 1\text{s}$, $\text{Cut-Off} = 40 \text{ rad/s}$



Efficiency-Time plot to determine the long term behavior



task 8 - Power, $T = 1\text{s}$, $\text{Cut-Off} = 40 \text{ rad/s}$

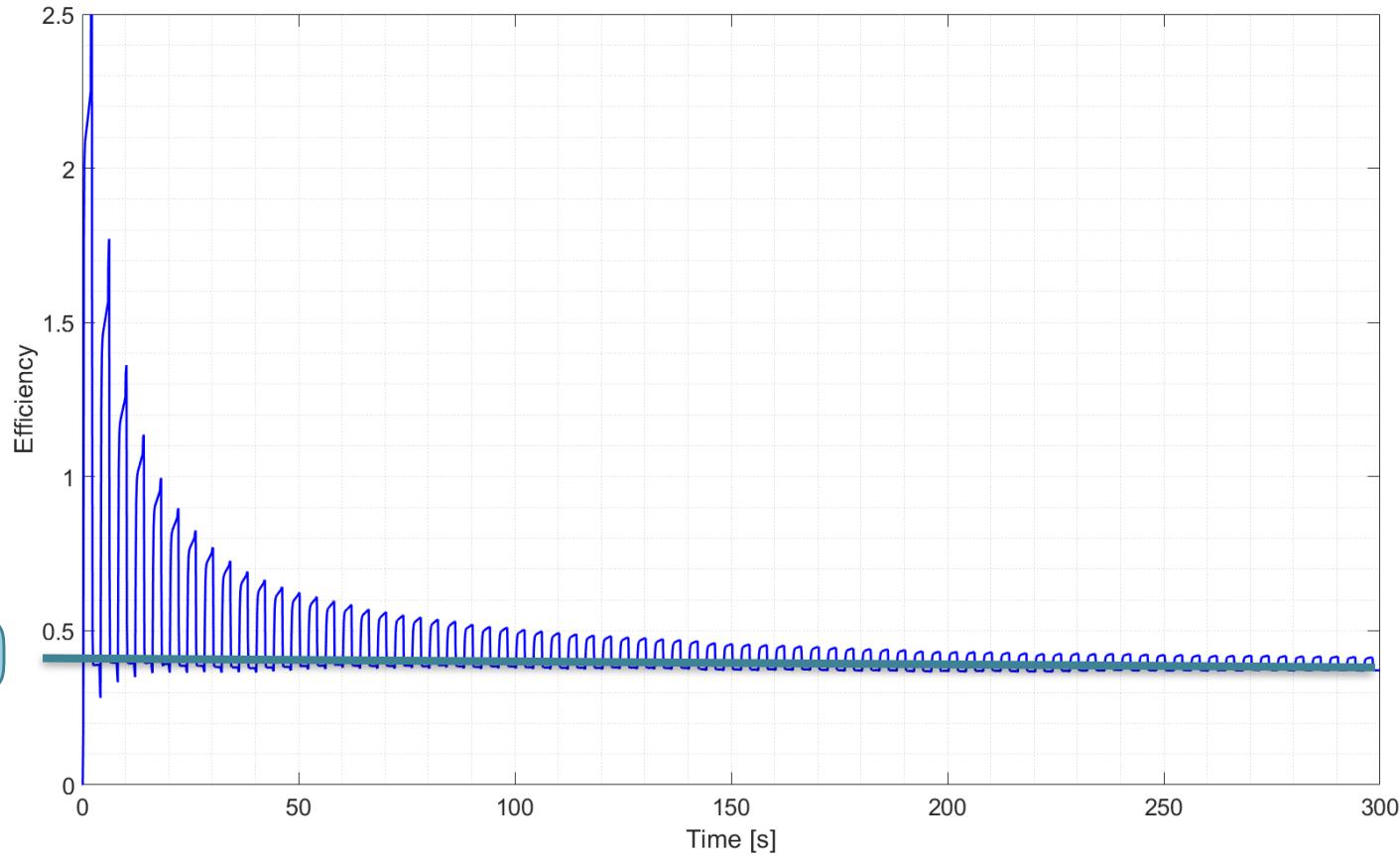


Power -Time plot to determine the long term behavior

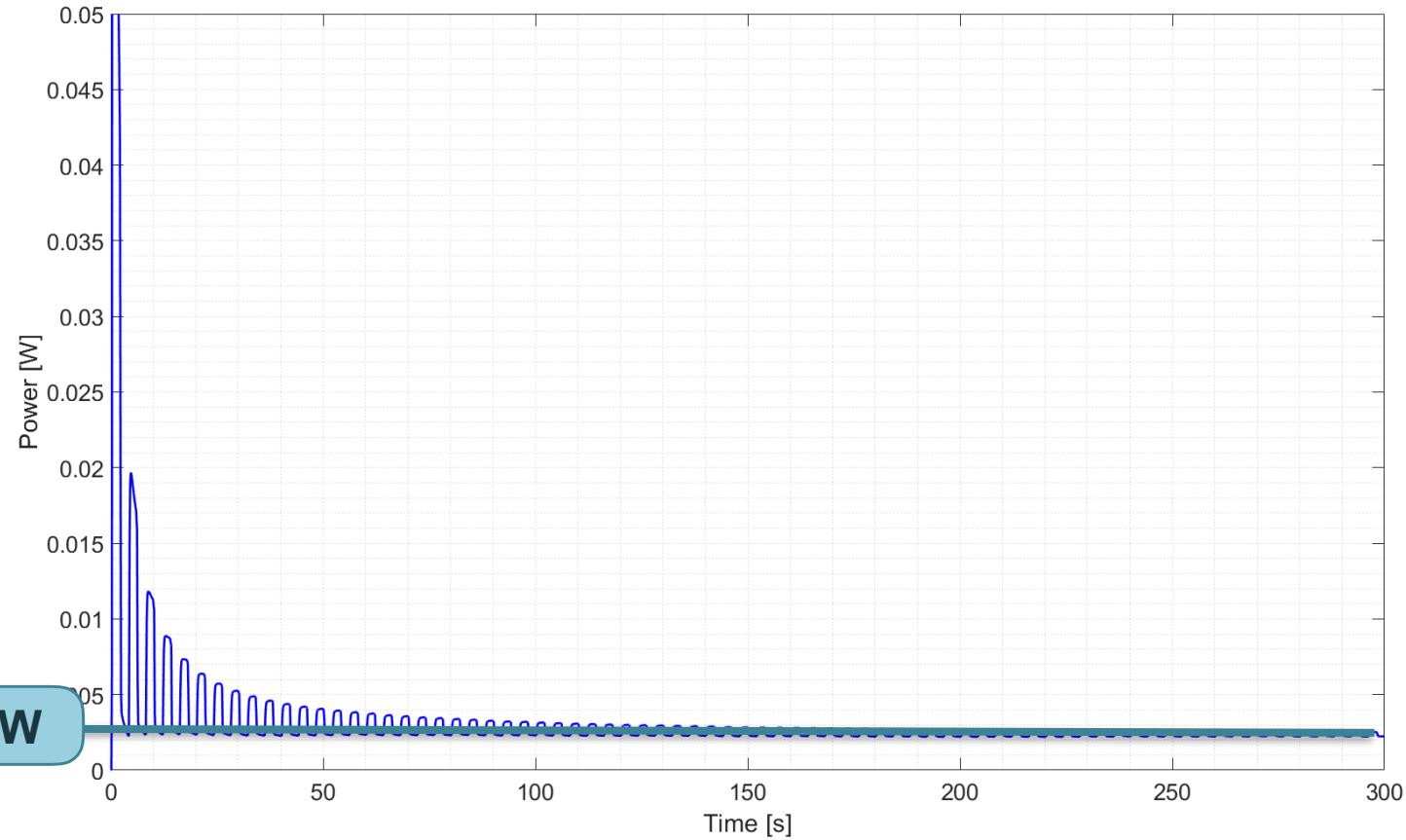


task 8 - Efficiency, $T = 4\text{s}$

Cut-Off = 10 rad/s



Efficiency-Time plot with different external force parameters



Power-Time plot with different external force parameters



Thank you for your attention!
Questions?

