Record Number of Masses and Spring Number:

Number of Masses = ________ , Nominal Mass of System: \( M = \) ________

Spring Number = ________ , Gain Value: \( K_{pf} = \) ________

1. From the Step Response plot obtain the following information:

   a. Find a peak value and its relative time of occurrence.
      \[ x_{max} = \quad T_p = \quad \]

   b. Calculate the damped frequency. \( \omega_d = \frac{\pi}{T_p} = \quad \)

   c. Find the steady-state value of the mass position. \( A_1 = \quad \)

   d. Calculate the Percent Overshoot from \( x_{max} \) and \( A_1 \).
      \[ P.O. = \left( \frac{x_{max} - A_1}{A_1} \right) \times 100\% = \quad \]

   e. Calculate the damping ratio from the percent overshoot.
      \[ \zeta = \sqrt{\left[ \frac{\ln^2(P.O./100)}{(\pi^2 + \ln^2(P.O./100))} \right]} = \quad \]

   f. Calculate the natural frequency of your system. \( \omega_n = \frac{\omega_d}{\sqrt{1 - \zeta^2}} = \quad \)

   g. Using the nominal mass value of your system, calculate the spring constant.
      \[ \frac{K}{M} = \omega_n^2 \quad \rightarrow \quad K = \omega_n^2 M = \quad \]

   h. Using the damping factor, \( \sigma = \zeta \omega_n \), calculate the damping constant, \( B \).
      \[ \frac{B}{M} = 2\sigma \quad \rightarrow \quad B = 2\sigma M = \quad \]

   i. Record the reference step input value used to excite the system. \( A = \quad \)

   j. Find the hardware gain value using the values from 1.c., 1.f., and 1.i.
      \[ K_{hw} = \frac{A_1 M \omega_n^2}{A K_{pf}} = \quad \]

   k. Write down the transfer function of your system.
      \[ G(s) = \frac{K_{hw}}{s^2 + \frac{B}{M} s + \frac{K}{M}} = \quad \]

   l. Determine the pole locations of your system model.
      \[ p_1 = \quad \]
      \[ p_2 = \quad \]