HOMEWORK:

Open loop transfer function of a unity feedback system is given as

\[ G(s) = \frac{K(s + a)}{s(s + b)(s^2 + cs + d)} \]

1. i) By using pencil-and-paper, derive the expressions of the responses of the closed loop system for the following input functions:
   a) Unit Impulse
   b) Unit Step
   c) Unit Ramp
   d) Unit Parabola

   ii) Propose a method to plot the responses by hand. Using this method plot the unit step response of the c.l. system roughly.

2. Calculate the steady state errors (\(e_s\)) of closed loop system for each input function in (1).

3. Find the poles of the closed loop system. Using the dominant two poles, obtain a second order approximate of the system. According to this approximation, calculate the following specifications for closed loop system when the input is a unit step function.
   a) Percent Overshoot, PO
   b) Rise Time, \(T_r\)
   c) Peak Time, \(T_p\)
   d) Settling Time (for 2% criterion), \(T_s\)

4. Plot root locus diagram by taking \(K\) as a free parameter. Based on root locus, propose a value for \(K\) for “good response”. For this value of \(K\), plot the closed loop response to unit step.

5. By using MATLAB and control toolbox;
   a) Obtain and plot the responses of the closed loop system for the input functions in (1)
   b) Find \(e_s\) values from your MATLAB plots for inputs listed in (1)
   c) Obtain the transient performance measures (listed in question 3) from the related MATLAB plot. Compare with your answers to question 3.
   d) Plot root locus by using MATLAB. Answer question 4 by using MATLAB root locus plot.