EE324, Control Systems Lab, Problem sheet 2
(Report submission date: 24th January 2021)

Analysis in time domain:

Q1a: In Scilab, build a **continuous** time LTI system with transfer function G(s) = a/(s+b), where a is equal to the last two digits of your roll number, and b is equal to the position in the alphabet of the first letter in your first name. Show all the steps in your report.
Hint: use the command `syslin`.

b: Plot the response of this system to a unit step input. Save the plot and include it in your report (taking a screenshot is not allowed). Show the following points clearly in your plot: time constant, 2% settling time, and rise time.

c: Vary the parameter a from its original value to 100 times that in steps of a. Show by means of a plot how rise time varies with this variation in a.

d: Vary the parameter b from its original value to 100 times that in steps of b. Show by means of a plot how rise time varies with this variation in b.

Q2: Plot the step response of a standard, under-damped second order continuous time system with no zeros. Show the response in your report and, also, all the intermediate steps you followed to arrive at the plot. Write the damping ratio you used for this example.

Show by means of a series of plots (one single figure) the step responses of the above-mentioned standard second order system as its damping ratio varies from 0 to 2 in steps of 0.25. Observe how percentage-overshoot, rise-time, 2% settling time, and peak-time change with change in damping ratio.

Q3: Build two continuous time systems, one first order and the other second order, both without any finite zeros, such that both the systems have their step responses increase monotonically from initial value 0 to final value 1. Show these two step responses in a single plot, put it in your report. Write in your report the salient points of differences between these two responses. Check if step response is monotonic when we have repeated poles in the second-order system.

Q4a: Consider a continuous time single-integrator (G(s) = 1/s) . Plot response to the unit step of the system with transfer function G(s). (Use `csim` command.) Write commands in report.

Q4b: Build a **discrete** time transfer function 1/z (again using syslin but not with the ‘c’ option) and now simulate using the **discrete** time step input. (For simulation, using ‘dsimul’.) Comment in the report on how the response is different.

Q4c: Build just a ratio of two polynomials such as 1/z or 1/s and **try** giving them as input to csim. Compare the difference for Q4 a, b and c. Why are the conclusions different?

Q5: Compare three types of responses for the transfer function G(s)= (s+5)/[(s+4)(s+2)]. First: consider output of G(s) for step input. Second: series (in this order): step input first through (s+5)/(s+4) and then 1/(s+2) and then vice-versa. Change the sampling period of the unit-step and check if some error creeps in the three plots superimposed. (In the command ‘csim’ (whose arguments are u, t, system), choose time series t (using syntax t=[0:tau:10]) as a vector of time-instants, in the time-step tau is each of 0.1 seconds, 0.5 seconds, and 2 seconds.)