Problem 1

Many chemical processes can be modeled by a transfer function of the following form

\[ G(s) = \frac{K}{(\tau s + 1)} \]  

(1)

Obtain the combined ZOH and analog system transfer function \( G_{ZA}(z) \) of the system as a function of parameters \((K, \tau)\).

Problem 2

Find the discrete time transfer function for the \( RL \) circuit in figure 1 using the following methods:

1) Tustin transform:
\[ s = \frac{z - 1}{z + 1} \frac{2}{T} \]  

(2)

2) Forward Euler approximation:
\[ s = \frac{z - 1}{T} \]  

(3)

3) Backward Euler approximation:
\[ s = \frac{z - 1}{T} \]  

(4)

4) Matlab command c2d with zero order hold.

5) Matlab command c2d with first order hold.

6) Plot the step response of the digital system for each one of the previous approaches of questions 1)–5) and compare.

For the first three questions, you need to substitute \( s \) by its \( z \) domain approximation and simplify the transfer function. Pick appropriate values for \( R \) and \( L \). Use the same sampling period and discuss you results. Hint: to know more about c2d, type help c2d.

Problem 3

In a digital control system the DAC is modeled as a zero order or a first order hold system. We want to compare between the two approaches using simulink. The simulink block diagram is shown in figure 2. Construct the block diagram, run the simulation and compare. Use the same sampling period for the ZOH and FOH. Change the sampling time and see what happens.