ELEC-E8101 Digital and Optimal Control
Exercise 7
Autumn 2022

1

Determine the sampled version of the system

$$G(s) = \frac{1}{10s+1}$$

by the methods indicated below. Sampling time $T_s = 1$.

a. Forward difference (aka Euler method)
b. Backward difference
c. Tustin's approximation
d. Step invariance

2

The continuous-time PI-controller has the transfer function

$$G(s) = K(1 + \frac{1}{T_I s}).$$

a. Determine a sampled version by Tustin's approximation. Determine how discrete-time parameters depend on the continuous time parameters.
b. Euler approximation of an integral corresponds to the forward difference method. It can be written as

$$\int_0^T g(t)dt \approx \sum_{i=0}^{T/h} hg(ih)$$

where *h* is the discretization step length. Using this, time domain version of a discrete time PI-controller can be written (dropping the sampling time / assuming $T_s = 1$ for notational simplicity)

$$u(k) = Ke(k) + \frac{K}{T_I}\sum_{i=0}^{k} e(i)$$

Form the corresponding *incremental algorithm* (velocity form). Note: the incremental algorithm is not covered in the lectures.