# Continuous to Discrete Transfer Function Transformation Using the Euler Methods

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# 1 EULER CONTINUOUS TO DISCRETE TRANSFORMA-TIONS

Consider a continuous transfer function H(s) that we wish to transform to a discrete transfer function H(z) using a sampling period of T and some approximation method (i.e. some approximate transformation). Both the **forward Euler** and **backward Euler** are transformations based on evaluating H(s) at some value of s representing an *approximate* transformation between s and z [1].

### 1.1 Forward Euler

$$s \leftarrow \frac{z-1}{T} \qquad \therefore H(z) = H(s)|_{s = \frac{z-1}{T}}$$

### 1.2 Backward Euler

$$s \leftarrow \frac{z-1}{Tz}$$
  $\therefore H(z) = H(s)|_{s=\frac{z-1}{Tz}}$ 

## 2 REFERENCES FOR CODE

#### Syms to TF Conversion (syms2tf.m) [4]:

• Conversion of a symbolic function object to a transfer function object.

#### SYM2TF: a matlab function which converts symbolic math rationals to transfer function object [3]:

• Conversion of a symbolic function object to a transfer function object.

# How can I convert a transfer function object from the Control System Toolbox into a symbolic object for use with the Symbolic Math Toolbox? [2]:

• Conversion of a transfer function object to a symbolic function object.

### REFERENCES

- [1] Gene F. Franklin, J. David Powell, and Michael Workman. *Digital Control of Dynamic Systems*. 3<sup>rd</sup>. Half Mooon Bay, CA: Ellis-Kagle Press, 1998.
- [2] How can I convert a transfer function object from the Control System Toolbox into a symbolic object for use with the Symbolic Math Toolbox? MATLAB Answers. https://www.mathworks.com/matlabcentral/ answers/96275-how-can-i-convert-a-transfer-function-object-from-the-controlsystem-toolbox-into-a-symbolic-object. (accessed: April 10, 2021).
- [3] Ichiro Maruta. *SYM2TF: a matlab function which converts symbolic math rationals to transfer function object*. GitHub Gist. https://gist.github.com/maruta/1035254. (accessed: April 10, 2021).
- [4] Crystal Nassouri. Syms to TF Conversion. MATLAB Central File Exchange. https://www.mathworks.com/ matlabcentral/fileexchange/27302-syms-to-tf-conversion. (accessed: April 10, 2021).