Continuous to Discrete Transfer Function Transformation Using the Euler Methods

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Contents

1 EULER CONTINUOUS TO DISCRETE TRANSFORMATIONS

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

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

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*. 3rd. 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-control-system-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).