

Lecture 5: Block diagrams

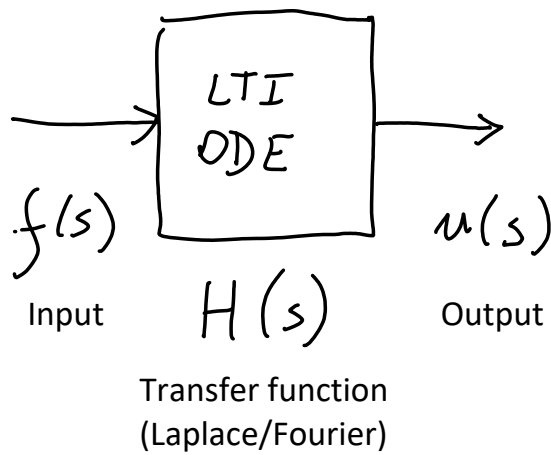
Thursday, October 15, 2020 8:40 AM

References:

Tranquillo JV. *Biomedical Signals and Systems*, Morgan & Claypool Publishers, Dec. 2013. Ch. 5 (Sec. 5.1 - 5.4).

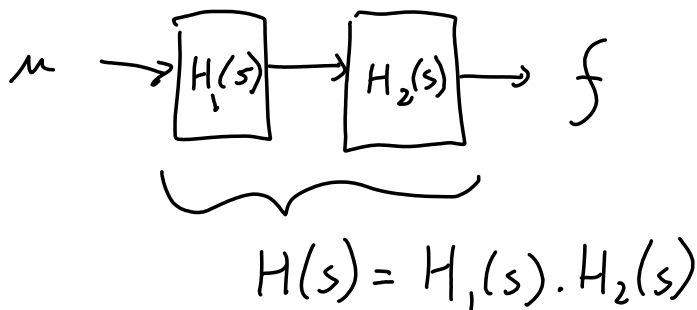
Ahmed R. *MATLAB Simulink Tutorial*, Udemy.

A block representing a LTI ODE and its transfer function:

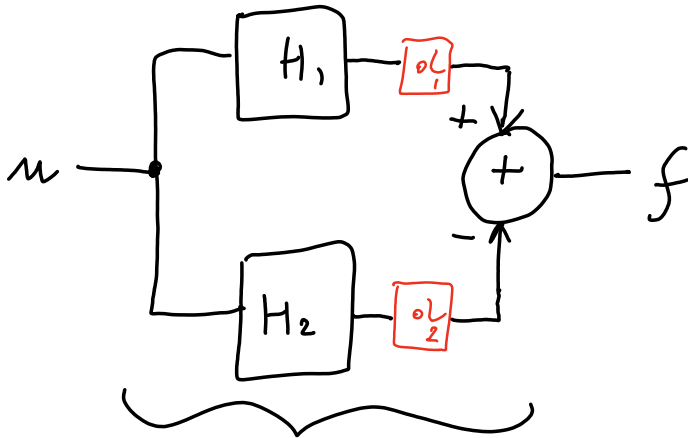


Combining blocks:

Series (cascade):



Parallel (junction):



$$H(s) = d_1 H_1(s) - d_2 H_2(s)$$

Constructing block diagrams for ODEs using fundamental building blocks:

$$\frac{du}{dt} = F(u, \dots, f)$$

$$= Au + bf$$

LTI ODE

$$= -\frac{1}{\tau} u + f$$

Example first-order system

ODE in integral form:

$$u(t) = \int_0^t F(\dots) dt$$

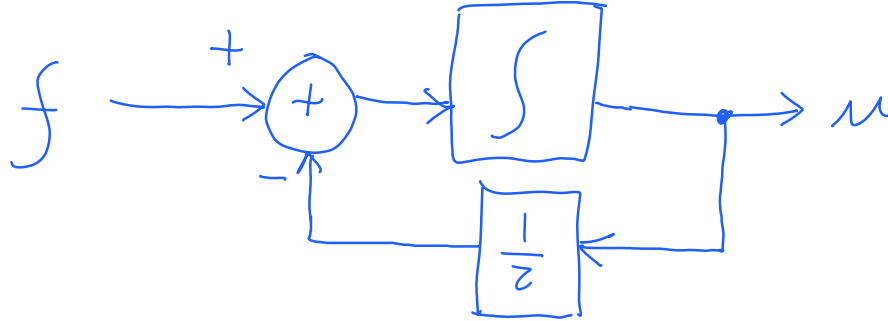
0 w/ I.C.
 $-\infty$ w/o I.C.

$$u(t) = \int_0^t \left(-\frac{1}{\tau} u(t) + f(t) \right) dt$$

$$u(s) = \frac{1}{s} \left(-\frac{1}{\tau} u(s) + f(s) \right)$$

$$\int dt = \frac{1}{s}$$

Equivalent block diagram:



MATLAB Simulink implementation (first_order_system.slx):

The image shows the MATLAB Simulink environment. At the top, the Simulink Library Browser is open, displaying various blocks. The main workspace shows a Simulink model named 'first_order_system'. The model consists of a step function block, a summing junction, an integrator block (labeled '1/s'), a gain block (labeled '0.2'), and a scope block. The scope block is connected to the output of the integrator. The MATLAB Command Window is open, showing the command 'isn beng122a simulink' and the prompt 'fx >>'. A Scope window is also open, displaying a plot of the system's response. The plot shows a smooth, increasing curve starting from the origin and leveling off as it approaches a value of approximately 4.5. The x-axis is labeled 'Time (units 1/2f_c)' and ranges from 0 to 10. The y-axis is labeled 'Decoder impulse response' and ranges from -0.5 to 4.5. The plot is titled 'Scope' and has a 'Sample based' time step of $T_s=10.000$.