

# Lab 3

*School of Architecture, Civil and  
Environmental Engineering*

*EPFL, SS 2020-2021*

[http://disal.epfl.ch/teaching/signals\\_instruments\\_systems/](http://disal.epfl.ch/teaching/signals_instruments_systems/)

# Lab 3 outline

- Concept:
  - Continuous-Time Transforms (LT, CTFT)
  - Discrete-Time Transforms (ZT, DTFT)
- Tools:
  - Matlab

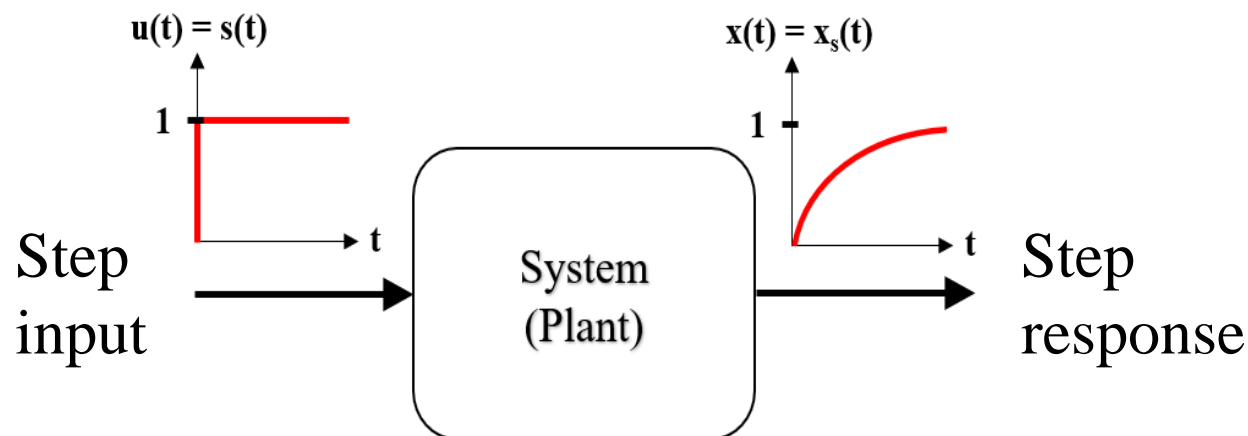
# Symbolic Toolbox in MATLAB

- `syms x,y` → Define symbolic variables
- `assume(x>0)` → Assumption on variables
- `sympref('HeavisideAtOrigin',1)` → Symbolic preferences
- `fplot()` → Plot symbolic functions
- `Heaviside()` → Step function
- `tf()` → Define transfer function
- `step()` → Plot step response
- `int()` → Symbolic integration

**\*\*\* Check MATLAB help to learn how to use it**

# Reminder: Impulse and Step Response

- **Impulse response:** Time evolution of its output when input is impulse function
- **Step response:** Time evolution of its output when input is step function



# Reminder: Fourier Transform

$$\hat{f}(\xi) = \int_{-\infty}^{\infty} f(t) \cdot e^{-i2\pi\xi t} dt$$

$$f(t) = \int_{-\infty}^{\infty} \hat{f}(\xi) \cdot e^{i2\pi t\xi} d\xi$$

The Fourier Transform is a special case of the Laplace Transform

`fourier()` → Symbolic CT Fourier Transform  
`ifourier()` → Symbolic Inverse CT Fourier Transform

# Reminder: Laplace Transform

$$F(s) = \mathcal{L}\{f(t)\} = \int_{-\infty}^{\infty} e^{-st} f(t) dt$$

$$s = \sigma + i\omega$$

\*The Laplace transform is an extension of Fourier transform to allow analysis of broader class of signals and systems

\*Check transform tables in appendix

`laplace()` → Symbolic Laplace Transform  
`ilaplace()` → Symbolic Inverse Laplace Transform

# Reminder: Z Transform

$$X(z) = \mathcal{Z} \{x[n]\} = \sum_{n=-\infty}^{\infty} x[n]z^{-n}$$

$$z = Ae^{j\varphi} \text{ or } z = A(\cos \varphi + j \sin \varphi)$$

\*Similar to Laplace transform but for discrete signal and systems

\*Check transform tables in appendix

`ztrans()` → Symbolic Z-Transform

`iztrans()` → Symbolic Inverse Z-Transform

# Reminder: Discrete Time Fourier Transform

$$X(\omega) = \sum_{n=-\infty}^{\infty} x[n] \cdot e^{-i\omega n}$$

The Discrete-Time Fourier Transform is a special case of the Z Transform

Transform discrete-time signals from time-domain to frequency domain (continuous spectrum)

No direct symbolic tool

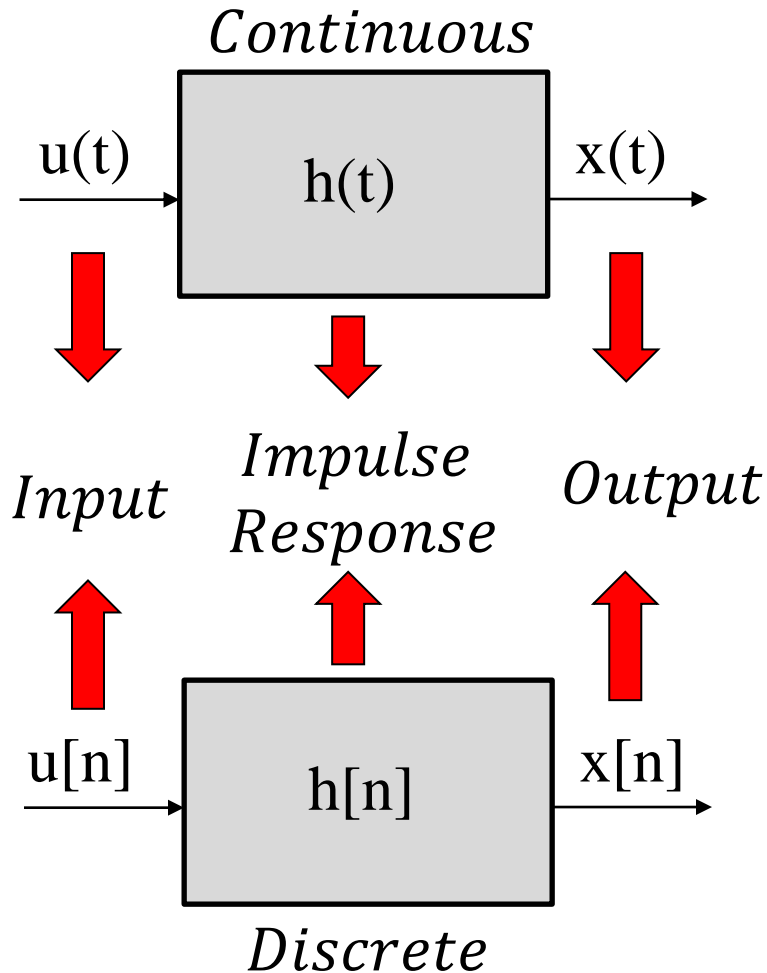
`fft()` → Numerical DF Transform

`ifft()` → Numerical Inverse DF Transform



# System Analysis with Transforms

*Cont.  
Transfer  
function*



- $x(t) = u(t) * h(t)$
- $X(s) = U(s)H(s)$
- $X(s) = \mathcal{L}(x(t))$

- $x[n] = u[n] * h[n]$
- $X(z) = U(z)H(z)$
- $X(z) = \mathcal{Z}(x[n])$

*Discrete  
Transfer  
function*

# General Remarks

- Questions for which you need to use Laplace and Z-Transform tables are Bonus
- Check MATLAB help to learn how to use functions
- Check given material, carefully read explanations and templates
- Pay attention to Hints and Notes
- It is about 3h, assistance will be given
- New lab, designed for you, will be improved

# Feedback form

Please fill the feedback form for Lab 3!