PHY408

Lecture 2: Linear Systems and Convolution

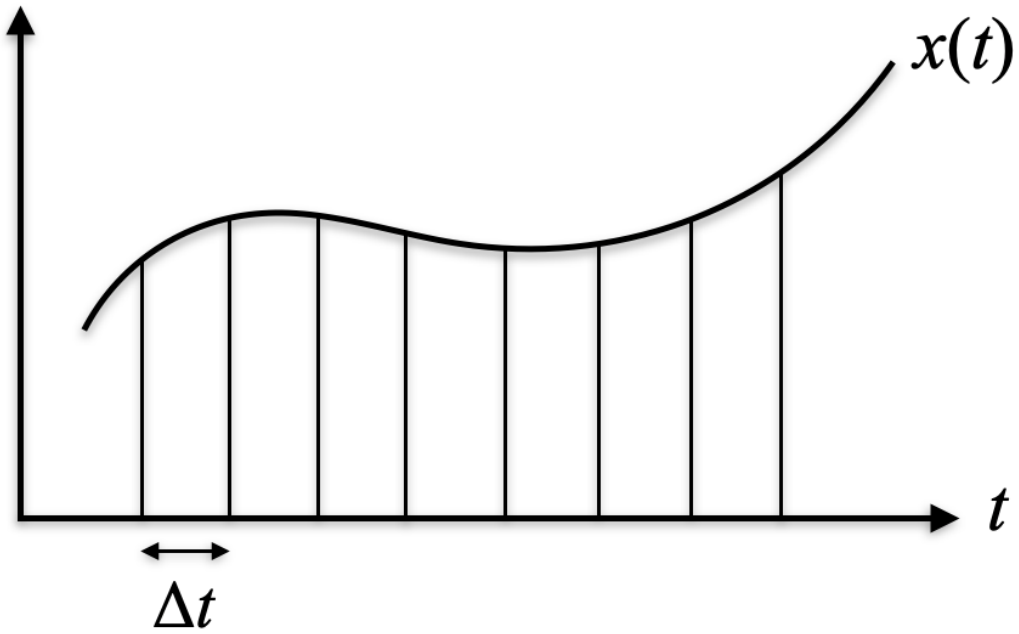
January 18, 2023

Lab 0: Due today

Important submission instructions:

- Your assignment submission MUST consist of TWO FILES: a pdf file and an ipynb file (if you use a jupyter notebok) or a pdf file and a zip file (if you do not use a jupyter notebook). You will lose marks if you do not submit both files.
- Please name your file as Lastname_Firstname_LabN.pdf.
- For each question in your assignment, include the names of the people with whom you collaborated. In the case where you had no collaborators, write “Collaborators: None.”

Signals



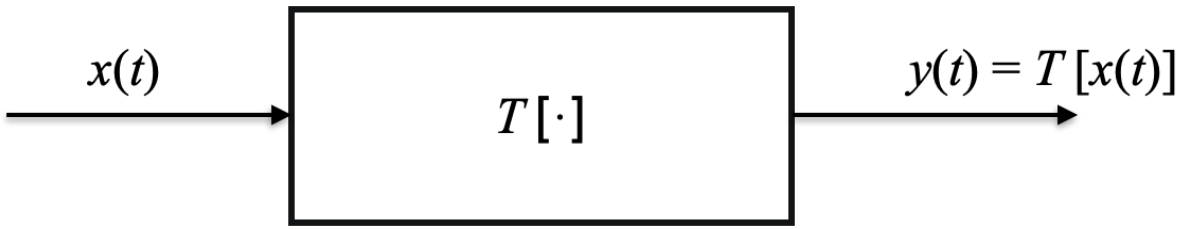
- Continuous-time signal: $x(t)$ represented by a continuous independent variable.
- Discrete-time signal: x_k, the independent variable has discrete values

$$x_k = x(k\Delta t) \qquad k = 0, 1, 2, ..., N \tag{1}$$

where Δt is the sampling interval.

Linear systems

A system maps an input signal $x(t)$ onto an output signal $y(t)$.



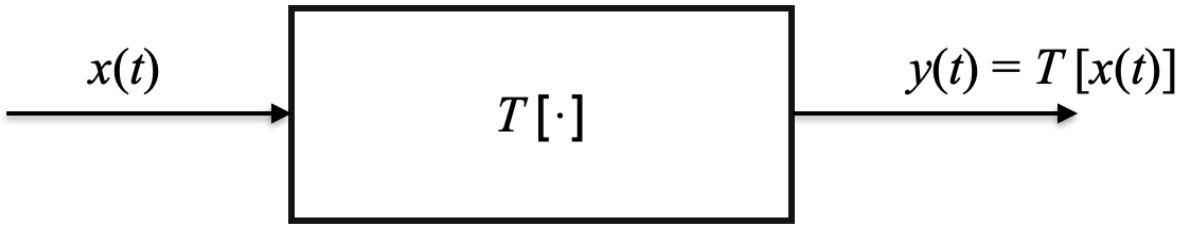
- Homogeneity: If we change the strength of the input by some factor, the output will also change by that factor

$$T[ax(t)] = aT[x(t)] = ay(t) \tag{2}$$

- Additivity: If $y_1 = T[x_1(t)]$ and $y_2 = T[x_2(t)]$ then

$$\begin{aligned} T[x_1(t) + x_2(t)] &= T[x_1(t)] + T[x_2(t)] && (3) \\ &= y_1(t) + y_2(t) && (4) \end{aligned}$$

Linear systems



- Time-invariant systems: A system for which a temporal shift in the input sequence produces a corresponding shift in the output.

$$T[x(t-s)] = y(t-s) \tag{5}$$

- Linear time-invariant systems (LTI): Can be represented by the response of the system to a unit pulse. This response is called the impulse response function of the system.