Signal transmission through Linear system, Impulse Response

Definition of an LTI system:
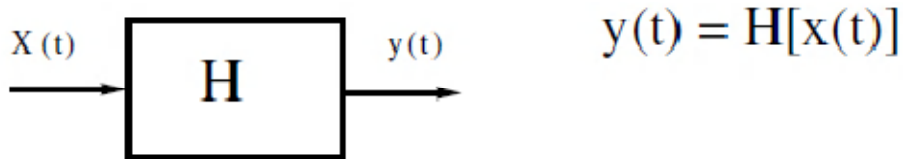
$$y(t) = H[x(t)]$$

Linear system: satisfies superposition principle.

$$H\big[\alpha_1 x_1(t) + \alpha_2 x_2(t)\big] = \alpha_1 H\big[x_1(t)\big] + \alpha_2 H\big[x_2(t)\big]$$

Time-invariant: (shift-invariant)

Let $y(t) = H[x(t)] \;\; \forall t_0,$ $H\big[x(t - t_0)\big] = y(t - t_0)$

LTI ¾ Linear Time Invariant system, our focus.
How to completely describe an LTI system?

(1) Impulse response (2) Transfer function

(1) Impulse response: h(t),
Let a system response due to an impulse input applied at t=0
be notated as $h(t) = H[d(t)]$,
   (1)   then, for an arbitrary input x(t)

$$y(t) = \int_{-\infty}^{\infty} x(\lambda) h(t - \lambda) d\lambda$$

$$= \int_{-\infty}^{\infty} x(t - u) h(u) du$$

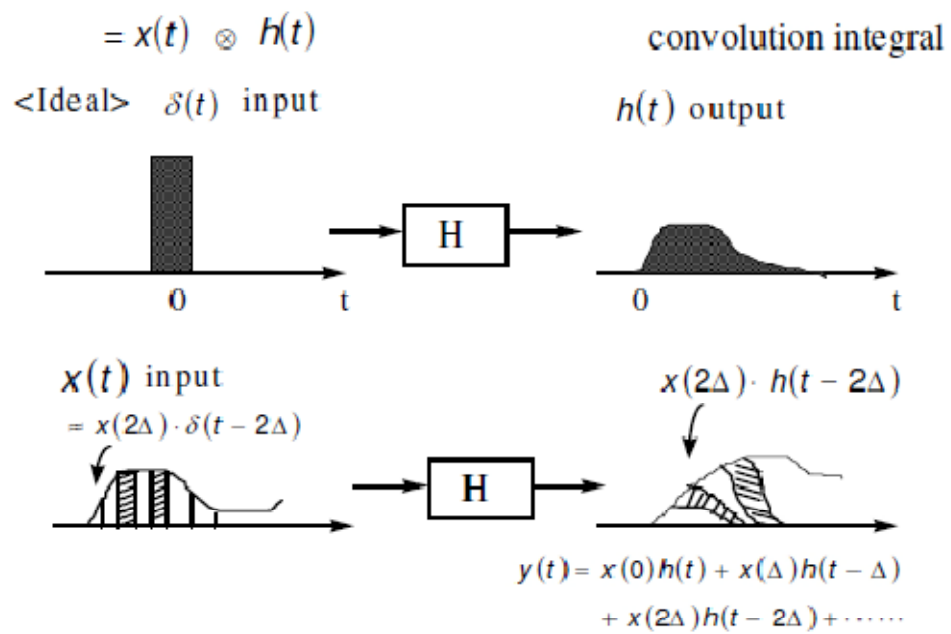$$= x(t) \otimes h(t) \qquad \text{convolution integral}$$

<Ideal> $\delta(t)$ input $\qquad\qquad\qquad$ $h(t)$ output

$x(t)$ input

$= x(2\Delta) \cdot \delta(t - 2\Delta)$

$x(2\Delta) \cdot h(t - 2\Delta)$

$$y(t) = x(0)h(t) + x(\Delta)h(t - \Delta)$$
$$+ x(2\Delta)h(t - 2\Delta) + \cdots\cdots$$

Figure 4.11