EE 150L
Signals and Systems Lab

Lab2 System Analysis in Time Domain

Student Id: 2021533042

Name: 周守琛

1. About system response

a) Describe the characteristics of zero-input responses and zero-state response briefly. What is the difference between the initial conditions of the two responses?

b) Consider a linear system whose zero-input response $\mathrm{y_{zi}(t)} = (4e^{-t} - 3e^{-2t})u(t)$ and the system full response $y(\mathrm{t}) = (3e^{-t} - 2e^{-2t} + te^{-t})u(t)$, what is the zero-state response of the system?

(a) The zero-input response: there is no signal input before time 0, and the response depends on the initial energy storage before time 0, it has initial state.

The zero-state response: the response before time 0 is 0 , its initial state is 0, and the system response depends on the signal x(t) added from time 0.

Difference of initial conditions:
Zero-input response : let f(t)=0, only need to use $y^{(k)}(0^-)$ to initialize.
Zero-state response : let f(t) be the input, not only use $y^{(k)}(0^-)$, but also need to calculate $y^{(k)}(0^+)$ by using integral, use both $y^{(k)}(0^-)$ and $y^{(k)}(0^+)$ to initialize.

(b) $y(t) = y_{zi}(t) + y_{zs}(t)$

So $y_{zs}(t) = y(t) - y_{zi}(t)$

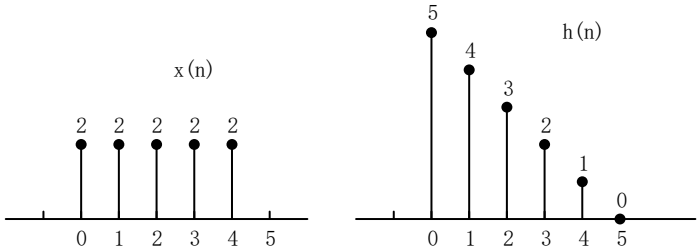
$= (3e^{-t} - 2e^{-2t} + te^{-t})u(t) - (4e^{-t} - 3e^{-2t})u(t)$

$= (-e^{-t} + e^{-2t} + te^{-t})u(t)$

2. Convolve the following two signals and record the result as y(n).

a) Please describe the convolution process in detail (both formulas and schematic are accepted).

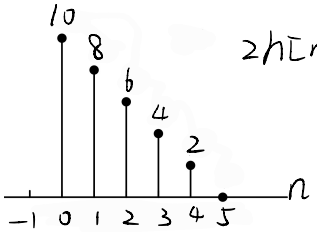
b) What is the relationship between the length of y(n) and the length of x(n) and h(n)?



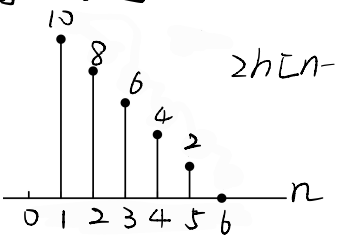
(a) $y[n] = x[n] * h[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k] = x[0]h[n] + x[1]h[n-1] + \cdots + x[4]h[n-4]$

$= 2h[n] + 2h[n-1] + 2h[n-2] + 2h[n-3] + 2h[n-4]$

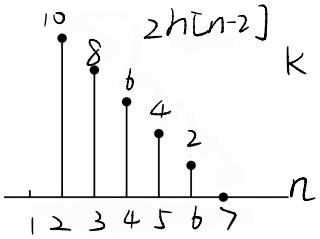
$k = 0$: $2h[n]$



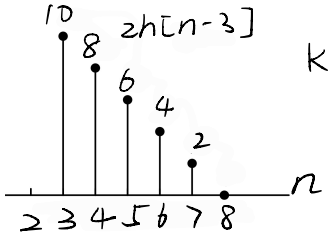
$k = 1$: $2h[n-1]$



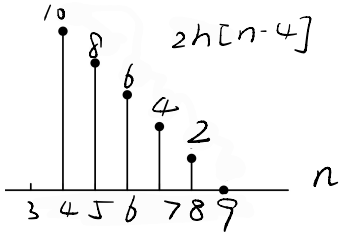
$k = 2$: $2h[n-2]$



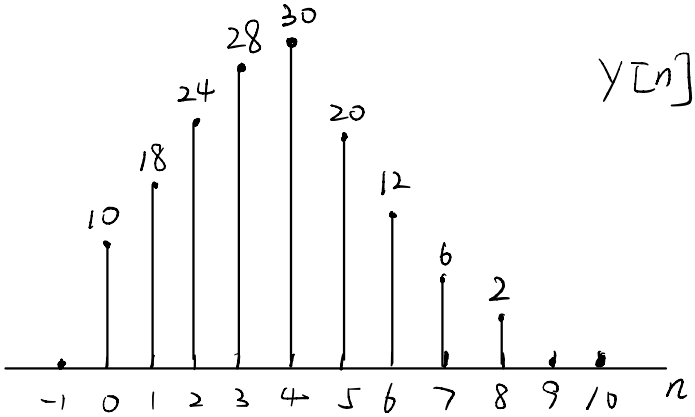
$k = 3$: $2h[n-3]$



$k = 4$: $2h[n-4]$



to sum up, we can get $y[n]$



(b) $length(y(n)) = length(x(n)) + length(h(n)) - 1$

$length(\cdot)$ is the length of the function